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GEOLOGICAL SURVEY REPORT,
No. 179.

REPORT

ON

YORKEY'S GOLD FIELD,

AND THE

MARODIAN GOLD AND COPPER FIELD.

WITH TWO MAPS AND ONE PLATE.

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REPORT ON YORKEY'S GOLD FIELD AND THE MARODIAN GOLD AND COPPER FIELD.

I.—Introduction.

I.—AREA AND LOCALITY OF THE FIELDS.

Yorkey's Gold Field, which is completely surrounded by freehold properties, is situated on the left bank of Running Creek, 9¼ miles in a direct line almost due north of Kilkivan, and is in the centre of the parish of Marodian, district of Wide Bay. It was proclaimed a provisional goldfield in 1894, the boundaries being the same as those of portion marked on the two-mile map as O.L., 1823, which is a forfeited selection of 80 acres.

Marodian Gold Field occupies the country at the heads of Calgoa, Sandy, and Running Creeks, which are all tributaries of Munna Creek, one of the chief affluents of the Mary River. This area, which has a general north-east and south-west trend, and is about 22 square miles in extent, was originally a forest reserve, but was proclaimed a goldfield in 1896, following the discovery of gold at Yorkey's.

II.—HISTORY.

The alluvial ground at Colo Flat, which is now included in the Marodian Gold Field, was "rushed" thirty-five years ago by some 300 men, the wash being found at a depth which varied from 25 feet in the centre to 6 feet at the side, and this was the beginning of mining in the district. The flat, which is only a few acres in extent, was worked out, as far as the majority of the claims were concerned, in a few weeks, and though the ground has often since been tried by fossickers, there is now only one lease in occupation for mining purposes.

The discovery of the Calgoa copper lodes was made about five years later, and in consequence most of the country north-west to the Munna was then leased for mining. Some of the mines at Thunder Creek appear to have been worked extensively, and a few of the leases are now being reprospected.

Copper was discovered at Mudloo by the Hon. H. S. Littleton's prospectors, but at that time the ore was not considered rich enough to work. During the last few years, however, much prospecting has been done, resulting in a small amount of ore being sent to the smelting works; but though three leases are reported to be now held, there was no one there at the time of my visit.

The next ground worked was a small patch of alluvial on the flanks of Yorkey's Hill, in portion 649, Marodian, which, being freehold, has not been tributed since the discovery of Yorkey's reefs.

Gold was found on O.L. 1823 by a bullock-driver in the year 1892, and a syndicate took up the ground, and named it "Yorkey's Surprise." In 1898 they sold the property to a company for one-half the new shares on condition that a 10-head battery should be erected, and last year a Gympie company bought the mine for £2,000 and one-quarter of the new shares. It is now proposed to work on a large scale.

Gold was subsequently found at several points in Yorkey's Paddock, portion 649, as a result of prospecting operations undertaken for Messrs. Mant and Littleton, and five mining leases—the Zealandia, Triad, Triad Extended, Waratah, and Beer and Dawson's—have been granted by the owner of the land. The Zealandia was worked by a small syndicate till 1901, and did not pay owing to the limited scale on which it was exploited, but the Triad and Beer and Dawson's are now in operation, and are paying fairly well.

2.—Geology.

I.—GENERAL.

The area examined is bounded on the east by Munna Creek and the Mary River, and on the west by the dividing range between Burnett and Wide Bay waters; on the north by Spring Creek, and on the south by the Mungar-Kilkivan Railway (see maps). It has an area of, roughly, 250 square miles.

Part of this strip of country forms the continuation of a belt of Gympie strata, which runs north-west from Gympie itself, and which is bounded by Burrum Coal Measures on the east, and by granite on the west. The Gympie rocks on the west, where they only form a capping, have been elevated much more than 1,000 feet above those on the east, which pass under the Coal Measures. The dip of the strata can only occasionally be determined, and where measureable, it was generally found to be to the south-south-west at a high angle.

Though the slates and the associated rocks have all been mapped as Gympie, there are three well-marked petrological divisions—(*a*) interbedded volcanic rocks, (*b*) carbonaceous slates, and (*c*) quartzose schists. Interbedded and intrusive igneous rocks (andesites, trachytes, diorites, and syenites) are especially developed near the Mudloo granite area, but they also occur at intervals from Teebar down to within 5 miles of the Kilkivan Railway. The volcanic rocks and slates must be much younger than the schists, but the volcanics would seem to be of younger age than the greater portion of the slates.

Towards the east there is a well-defined belt of limestones, striking north-north-west and extending, with slight breaks, from the Burnett River to Marodian Head Station. Recognisable fossils occur in parts of these limestones, but, as a rule, the rock is highly metamorphosed—the purer portions into marble, the more impure into wallastonite, garnet, &c. Among the fossils found at Gigoomgan are: Foraminifera, zaphrentis, productus, spirifera, modiola (?), aviculopecten, pleurotomaria, conularia (?), and crinoids, while on the flanks of Mount Urah, east of Marodian, spirifera, pleurotomaria, &c, occur.

Granite areas occur at Mudloo, Mount Urah, Brooyar, and on Calgoa, Spring, Kurrunda, and Miva Creeks, all except the lastnamed being associated with the Gympie beds. The Mudloo granite is chiefly hornblendic, though sometimes simply biotitic, and, in the southern and eastern edges, even aplitic; the others are biotitic, and in spite of the slight variations in their composition these granite masses may, with some certainty, be taken as being all connected at a depth. As to the period in which the intrusion of the granites took place, it must be said that there is very little strong evidence to go on, though the highly metamorphosed state of the Marodian limestones points to the neighbouring granite having intruded them. There are no sections available, however, showing actual intrusions. The granite at the head of Calgoa Creek, above Thunder Creek, is certainly intrusive in the slates, and numerous large granite dykes, which have run out from the Kurrunda mass into the slates and breccias about the Queen of the West Mine, prove the intrusive origin of that granite. The Mudloo granite has been cut through by very numerous dykes (syenites and quartz diorites), and there are corresponding masses between the slates and granites. The interbedded andesites, in the higher part of the slates, may have been derived from some of these dykes, in which case the granite would be of Permo-Carboniferous age.

Diorite forms the greater part of Yorkey's Paddock, occupying an area of about a square mile, and the same rock is found at Colo, covering an area a few chains wide and a quarter of a mile long. This diorite has rather the form of a plug than a dyke, and in it differentiation of the magma has taken place, for the western edge is much more acid than the remainder. It is quite possible that the diorite fills the deeper portion of a vent, from which part, at least, of the Boonara and Kilkivan andesite was poured forth.

In or adjacent to these diorite areas the payable auriferous reefs of Yorkey's and Colo occur, and auriferous reefs and leaders, which, however, have not yet been proved payable, have been found in the slates for more than a mile east of the diorite.

Igneous dykes are very numerous between Yorkey's, Calgoa, Mudloo, and Kilkivan. At Yorkey's they are porphyrite, felsite, and rhyolite in diorite; at Calgoa, coarse diorite in granite; and at Mudloo, porphyritic quartz diorite and syenite in granite. Outside these areas, the dykes, though numerous, are much more scattered and vary more in character and composition. No basic dykes were noticed during the whole examination, though some of the interbedded flows at Kilkivan must be either olivine andesite or basalt (decomposed). The dykes occur in the vicinity of the ore deposits at each of the above-mentioned localities. At Yorkey's they plainly follow two sets of fissures, one running about east and west, the other east-south-east and west-north-west, while the reefs themselves occupy corresponding fissures; and the inference is that the dykes at all these places have been connected with the ore concentration.

II.—TOPOGRAPHICAL.

The topography of the country necessarily depends on its geological structure, the gently dipping Burrum sandstones forming flat sandy country, covered with rather dwarfed eucalypts and swamp vegetation. Stock seem to thrive well upon this land when cleared, owing to its power of retaining moisture.

The granite, as a rule, makes good rolling grass land, but in places, as at the heads of Calgoa and Running Creeks, where decomposition has not kept pace with denudation, the country is exceedingly rough and stony. In other parts—*e.g.*, between Yorkey's and Kilkivan—a slightly different variety of granite has produced a very sandy soil, and the country is gently undulating. The granite soils, as a rule, carry good timber, especially ironbark, and about Mudloo the steeper hills are clothed with dense vine and pine (hoop) scrub.

The diorite produces a fine red loam, which carries good grass, and should make a first-class agricultural soil. Its contours are gently swelling.

The country—shown on the map as belonging to Gympie formation—is diversified in character. Where—chiefly in the higher parts—there are interbedded volcanic rocks, the hills are rounded or conical, and the brown soil produced carries fair timber and good grass, but sometimes pine scrub. Where the slates are argillaceous and indurated, the hills are rocky and precipitous and the soil is poor, though owing to its power of retaining water, it often carries pine scrub, and the grass paddocks on it are the last to feel the effects of a drought.

3.—Mines on and near Yorkey's Gold Field.

I.—YORKEY'S SURPRISE.

Yorkey's Surprise is a goldmining lease of 16 acres in the north-eastern corner of the goldfield. (See Map 1 and Plan 1.) The reef—known as the Surprise-Zealandia—outcrops only a few chains within the goldfield, striking about 13 degrees north of west, but dipping south under the field.

On it a shaft, 10 by 6 feet, and underlying about 1 in 1, has been opened to a depth of 250 feet, and levels have been carried along the reef to the west at 40 feet, and east and west at 90, 130, 180, and 230 feet depths. The total length of the levels is 720 feet. It is understood that the ground has been stoped out between the levels, but at present (May) the mine, below a depth of 190 feet, is flooded.

The average thickness of the reef in the present faces is from 2 to 6 inches, but it is reported that the average working width was 8 inches. As in

the Triad, to be described later, there is sometimes 2 feet of quartz-veined country carrying gold. The reef consists of crystalline, sometimes slightly radiating, tinted, quartz, which in places carries much stibnite, pyrite, &c., and is then richest in gold. The footwall is well-defined, but there is no proper hanging-wall, the quartz-bearing solutions having eaten into it for variable distances. Work was stopped because of the reef having pinched in all directions.

The pinching of the reef was predicted by the manager of the Zealandia, as the same zone passed through his mine. It is, therefore, to be expected that an improvement will take place on further sinking.

The country rock is diorite.

The returns from the mine as furnished by the Gympie warden are:—

For 1894—None								
„ 1895—? (yield 160 oz.)								
„ 1896—	69 tons	7 cwt.	crushed at	Gympie	for	83 oz.	2 dwt.	6 gr.
„ 1897—	87	11	„	„	„	75	8	0
„ 1898—	163	0	„	„	„	228	0	0
„ 1899—	17	11	„	locally	„	14	0	0
„ 1900—	549	0	„	„	„	319	5	0
„ 1901—	1,290	0	„	„	„	780	0	0
„ 1902—None								
	2,176 tons 9 cwt.					1,499 oz. 15 dwt. 6 gr.		

The fall in the yield per ton since 1899 is due to insufficient sorting for the local mill. This mill, which consists of ten head of stampers, with copper tables and Frue vanners, is, with boiler and engine, all housed in one shed. The new company proposes to install an electrical plant for lighting and for driving the drills, and the dynamos will be driven by steam-engines as there is no available head of water.

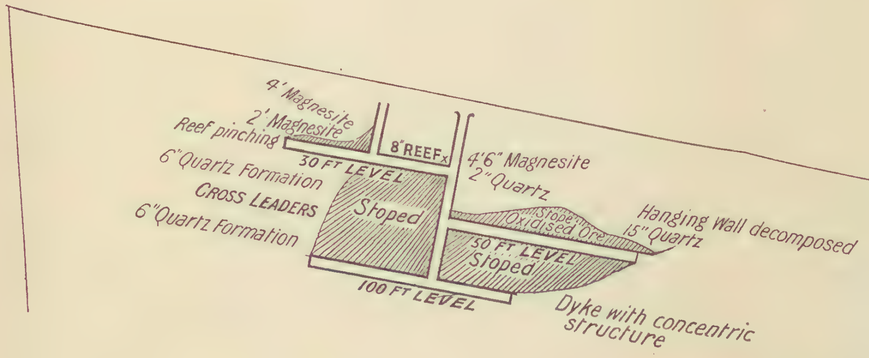
II.—ZEALANDIA.

The Zealandia is a lease of 3 acres in the freehold adjoining the Surprise on the east (See Map 2 and Plan 1.) The Surprise reef has been sunk upon, on the underlie, to a depth of 170 feet, and levels have been opened at 75, 110, and 160 feet depths. Between the levels the ground has now been stoped out. The mine, below the 110-feet level, is under water; but above that the reef has an average width of 6 or 7 inches, and it is as much as 4 feet thick in places. The manager informed me that he considered the average payable width throughout the mine as 7 or 8 inches. The quartz and the reef have the same characters as in the Surprise, and the dip (to S. 10 degrees W.) increases from 27 degrees near the surface to about 42 degrees in the lower workings. The country, as on Yorkey's, is diorite.

The Gympie warden gives the total returns, to the end of 1901, as 400 tons for an average yield of 18 dwt. of gold per ton. This was not found to pay on a small scale of working, so operations have ceased for the time being, but it is thought probable that the property will be purchased by the company owning the adjacent leases—Surprise and Scottish Marodian.

III.—TRIAD.

The Triad is a lease of 5 acres on freehold ground adjoining the Surprise, on the north. (See Map 2, and Plan 1.) The reef as shown on the map strikes in a slightly different direction (*i.e.*, E. 40 degrees S.) to the Surprise, and underlies on the same side. It is in the same diorite country, and has not been proved beyond where shown, but there is a probability that it is a faulted portion of the Surprise reef; and the north-north-east striking fault occupied by the dyke east of the shaft may have caused the heave. Shallow



PLAN 1
TRIAD SURPRISE & ZEALANDIA WORKINGS

FROM SURVEYS BY A. NEWTON

TO ACCOMPANY REPORT

BY

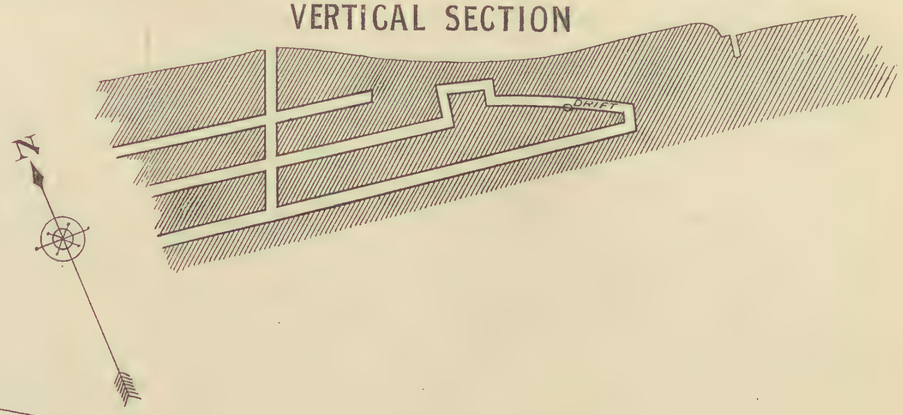
LIONEL C. BALL B.E.,
Assistant Government Geologist

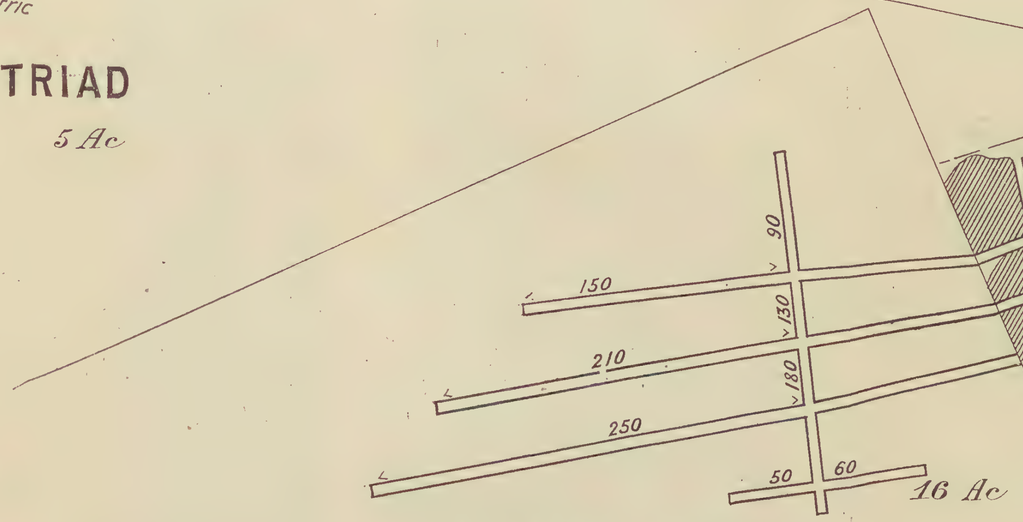
1902.

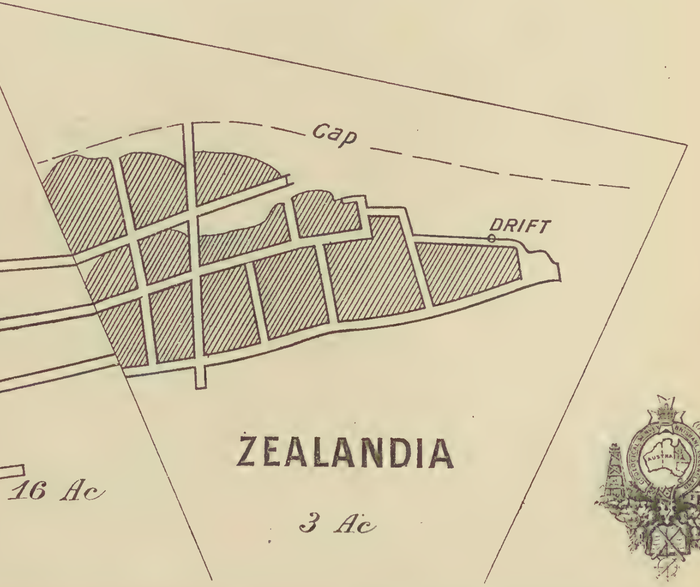
Scale 100 Feet to an Inch.

100 75 50 75 0 100 200 300

A. McLaren Del







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holes have been sunk but without success, in search of the Surprise reef, on its proper line of strike within this lease. The Surprise reef in the upper levels was strongly impregnated with stibnite, but, though the Triad also carried the mineral, pyrite and galena were more abundant in it.

A shaft, underlying from 1 in 1 to 1 in 2 vertical, has been sunk to a depth of 110 feet, and levels, 100 yards in total length, carried along the reef to the east at 30 feet, to the west at 50 feet, and both ways at 110 feet depth.

The vein material consists of the same peculiar tinted quartz, with included country rock, as in the Surprise. It averages 8 inches in thickness, and varies from 2 inches to 2 feet, carrying sulphides up to 3 or 4 per cent. which contain 3 oz. of gold per ton. The reef is overlain in the lower levels by as much as 4 feet of quartz-veined country, the quartz in which carries gold and is put through the mill. Above the water level, which is about 100 feet below the surface, instead of quartz-veined country there is from 6 inches to 3 feet of impure earthy and porcellaneous dolomite, the lime and magnesia of which have been derived from the weathering of the diorite. This is always on the hanging-wall side of the reef, the descending solutions evidently having been unable to sink through the quartz. The footwall of the reef is always good, but the hanging-wall is necessarily indefinite owing to its replacement by the quartz.

There can be little doubt that the fissure and the reef will continue to a depth.

A dyke of rhyolite (or felsite) with strong fluxion structure has been met with in the southern levels and outcrops on the surface (see Map), and it is believed to cut through the reef.

Mr. Newton, the manager of the Triad, provided me with the following returns, complete to May, 1902 :—

Date.	Stone Crushed.	Return.	Bullion.	Concentrates.
	Tons cwt. qr.	Oz. dwt. gr.	£ s. d.	Oz. dwt. gr.
	2 16 0	4 11 0	14 14 10	0 14 0
	11 1 0	17 5 0	62 11 0	0 16 0
	47 3 0	42 13 0	153 6 0	...
	36 0 0	42 10 0	158 10 8	4 18 0
	40 0 0	29 12 0	107 14 4	...
Mar. 1902	112 0 0	91 19 0	332 17 0	8 2 0
Apr. ,,	55 0 0	51 10 0	182 11 7	...
May ,,	68 0 0	77 0 0	275 19 5	4 5 0
	372 0 0	357 0 0	1,289 4 10	18 5 0
	...	18 5 0	69 7 0	...
	372 0 0	375 5 0	1,358 11 0	...

and in addition to the above, the Gympie warden has given me for June, 1902: 62 tons—53 oz. 10 dwt.

IV.—WARATAH.

The Waratah lease of 20 acres lies north of the Triad on the same freehold, but on a different line of reef, which strikes about east and west, and dips 1 in 5 vertical to the north; the average thickness of the reef being from 2 to 6 inches. Two shafts have been sunk, one 30 feet deep, the other 70 feet, with a drive 30 feet in length, and the outcrop has been traced by trenches for some 100 feet along the surface. The ore consisted in great part of carbonates of lime and magnesia, and the decomposed diorite country has been found to be slightly auriferous within 2 feet of the reef. Crushings are not available, but it was not considered payable by the lessee.

Near the top of the eastern shaft a dyke of felsite cuts across the reef and then sinks with it, and in this shaft is a 6-inch leader, of bluish fairly mineralised quartz, carrying 5 dwt. of gold per ton.

V.—BENSON'S.

Benson's lease of 20 acres, which is on the goldfield, is called Yorkey's Surprise No. 1 W., but the Surprise reef does not outcrop on it, and it must dip underneath. Several shallow prospecting shafts have been sunk, the deepest, 60 feet down known as the Well, having been begun to cut the Surprise reef at a depth of 500 feet. The undertaking was abandoned because of the failure of funds.

VI.—ORTT'S.

Ortt's 15-acre lease adjoins the Surprise on the south. The Surprise reef dips towards it, but should not be expected to be cut at a less depth than 600 feet.

Two other reefs called respectively Campbell's, and Ortt's, have been prospected, the former in the centre of the lease, and the latter on the boundary of the No. 1 W. They strike within 10 degrees of east and west, but dip in the opposite direction to the Surprise, *i.e.*, to the north, and the ore, which contains traces of copper and much hæmatite, as well as pyrites and a little gold, is quite dissimilar to that of the Surprise.

VII.—LAKE VIEW CONSOLS.

This is a prospective lease of 20 acres about midway between the Waratah and Beer and Dawson's Mines. (See Map 2 and Plan 1.) Two reefs, a little way off the line of strike of the Waratah reef, are shown on the plan.

On the southern one, which is 15 inches in thickness, and consists of promising cellular iron-stained quartz, a shaft has been sunk to a depth of 18 feet, but has fallen in. A sample taken from the ore heap assayed:—Gold, 3 dwt. 19 gr.; silver, 5 dwt. 5 gr. per ton.

A shaft was opened, and sunk to a depth of 20 feet on the second reef, but this also has collapsed. The reef at the surface consists of 2 feet 6 inches of rubbly quartz and mullock.

VIII.—BEER AND DAWSON'S.

Beer and Dawson's lease of 20 acres lies about a mile east of Yorkey's Gold Field, on the same freehold as the Triad, Waratah, &c. It will be seen from the plan that the junction of diorite and slate passes across the lease. The only work done so far has been in the slate, and the reef has been assumed to be the same as the Waratah, as it lies directly on the line, and strikes east and west. This may, however, be simply a coincidence.

Two vertical shafts have been sunk 28 yards apart, and respectively 40 to 60 feet deep (in May), and the former—the eastern one—has been abandoned for the present. The latter is now being deepened, stoping, for 30 feet east and west, having been carried above the 35-feet level to close to the surface. Much trouble was experienced in the eastern workings by repeated small faultings.

The reef is at times as much as 3 feet in thickness, without defined walls, and is rather peculiar in having a strong, generally central, fissure dipping about 1 in 20 to the south. In places the quartz pinches out altogether, or is found on one side only, owing to the solutions which carried it having been unable to attack the walls or wall at that place. The quartz carries much pyrite, a fair amount of galena, a little blende, calamine, black oxides, and green sulphates, and the average thickness is 10 inches.

The country near the reef is strongly "mineralised" but does not carry payable gold, and at 50 feet below the brace is the water level, where the reddish, oxidised, surface country changes to blue and grey unweathered clay slate.

The returns given me by the manager are:—8½ tons of picked stone, from the shaft down to 35 feet depth, yielded 5 oz. of gold per ton; 12½ tons, from 35 to 50 feet depth, in the shaft and partly from the level, yielded 2½ oz. per ton; and 17¾ tons of "firsts" from the stopes yielded 4¼ oz. per ton.

The Gympie warden reports for April, 1902:—18 tons 15 cwt. crushed for 71 oz. of gold. There are 200 tons of "seconds" now at grass, expected to run 10 dwt. of gold per ton.

Other reefs and leaders within the lease, chiefly on the knoll north of the present workings, have been prospected with indifferent results. A 2-feet reef of sugary and crystalline limonite-bearing quartz, about 80 feet south of the main shaft, *i.e.*, halfway to the diorite, carries a little gold.

IX.—SCOTTISH MARODIAN.

This is a freehold field of 30 acres, on the east of Yorkey's Gold Field, and south of Running Creek, and the Surprise reef, which should outcrop on the property, has not been found. A central shaft has been sunk, in augite diorite, to a depth of 450 feet (in May), in which it was expected that the reef would be met with at 350 feet, but such was not the case, and a drive is now being carried to the north in search of the reef.

It was unwise to sink before doing any surface prospecting, on account of the numerous cross dykes and the additional faults. There is a possibility of an east and west fissure, between the main shaft and the Zealandia, having heaved the reef to the west, beyond the shaft, and several small breaks in the Triad, and the assumed displacement of the Triad reef itself from the Surprise, point to this. Even if the dykes and faults have not affected the reef, the probability is that, towards the south, the Surprise-Zealandia reef becomes more nearly vertical in depth—in fact, the Surprise and Zealandia workings prove it so.

X.—DOMBRO'S.

Mr. Dombro informed me that a silver lode, about 15 inches in width, consisting of vesicular ferruginous quartz, with galena in the surface portion, runs east and west through his cultivation paddock—portion 14v, parish of Marodian. The lode cut out at 24 feet depth, and nothing can now be seen of the occurrence. The country rock is diorite.

4.—Mines on the Marodian Field.

I.—COLO GOLD MINES.

The Colo and the Three Bells are the only goldmines on the field, and they are in the extreme north-east.

The Colo alluvial ground has received intermittent attention from prospectors ever since its discovery, but no reef, of sufficient size to account for the gold in the wash, has yet been found. Much of the gold must have been derived from small leaders in the diorite, as is indicated by the prevalence of "colours" in the soil, and a few auriferous leaders have been found in the slates, south of the diorite area. Cruickshank's tunnel, 100 yards in length, was put into the hillside to cut one of these, which, when reached, was found to be unpayable.

(i.) Colo.—The present lease of 12 acres is about 3 chains west of the north-western corner of the township reserve between Colo and Running Creeks. (See Map 1.)

A shaft, worked about seven years ago, but now fallen in, is to be seen on the north-eastern corner of the lease. The leader is reported to have been sunk on for a depth of 70 feet, and driven on at 40 feet depth for a distance of 20 feet, and the first crushing of 10 tons yielded over an ounce per ton; the second, which came from 40 to 70 feet depths, yielded a little over half-an-ounce per ton. The ore from the drive ran 1 oz. per ton

Shallow prospecting shafts have lately been opened for a few chains along a leader, and a new shaft, 14 feet from the outcrop of the leader, is being sunk to 50 feet depth, when a crosscut will be opened. At 27 feet depth, where the leader was passed through in the shaft, it is reported to be 18 inches thick, but it cannot now be seen .Other leaders, dipping towards the main one, were cut at 18 and 40 feet depths.

The quartz in the ore paddock is sugary and iron and manganese stained, and carries very good gold.

The diorite country is decomposed to a depth of 30 feet, and below that it is much jointed and often altered (silicified) and mineralised (impregnated with sulphides) along the joints.

(ii.) Three Bells.—Nothing has been done at this mine since 1890, when Mr. Rands* visited it and reported unfavourably. The mine is on a dyke of granite in slates, about three-quarters of a mile east of the Colo Mine.

(iii.) "Silver" Mine.—These old workings, chiefly trenches, are on a hill on the left of Running Creek, about halfway between Mudloo and Yorkey's. The slates have been intruded and brecciated by a large dyke of granite porphyry, and have later been infiltrated by solutions carrying silica, hæmatite, &c The hæmatite, which was at first mistaken for silver, has a coarse platy structure, but there is not enough of the mineral present to form a workable iron deposit.

In connection with these, the Mount Colo manganese deposits should be mentioned, they also being apparently of secondary origin. (See Appendix 1.)

II.—MUDLOO COPPER MINES.

These are situated in the immediate vicinity of the junction of slates and granite, and the copper-mining leases within the goldfield are three in number—Sunnyside, Mount Mudloo, and White Rocks. Their approximate positions have been shown on Map 1. Copper stains and small veins are abundant on all of them, but the only payable lode appears to be that on Mount Mudloo. The copper in most, if not all, cases has been leached and concentrated from the overlying or adjacent interbedded and intrusive rocks, in the slates, and hence it should not be expected to increase in quantity at a depth.

Similar country extends in a south-easterly direction over the range into the Wide Bay catchment, where the Queen of the West was worked a few years ago, but the conditions are not more favourable than at Mudloo, and it was found advisable to cease operations. Mr. West, the discoverer of the deposit worked, informed me that 7 cwt. of ore, picked in 1900, ran 9·8 per cent. of copper.

(i.) Mount Mudloo.—This lease is 800 by 400 yards in area, and it is situated on the south side of the range, a quarter of a mile south of the south-western corner of freehold portion 844, Marodian. The workings are in the western part and consist of two adits, one 20 feet above the other; they are each 100 feet in length, and between them the lode has been stoped out.

As the stopes have been allowed to "run," little can be seen in the lower level, but it is concluded that the lode was from 1 foot to 2 feet 6 inches in

* "Report on the Coal Measures, Neardie Antimony Mine, and Teebar and Calgoa Copper Lodes."—By William H. Rands, Brisbane. By Authority: 1890.

width and dipped 1 in 10 vertical to N. 60 degrees E. In the roof of the upper level, the only place where the lode can be seen, it is only about a foot in width, and its dip is less than below. The ore there is not so rich as that obtained in the lower level, but the country is stained by copper carbonates.

The ore on the heaps consists of gossan, strongly stained with blue and green carbonates of copper; this ore, running about 20 to 25 per cent. of copper when hand-picked, cannot be considered rich. The immediate country rock is a somewhat decomposed granite porphyry. The walls of the lode, especially the hanging-wall, being good there need be no fear of the lode cutting out entirely near the surface.

The mine was closed down last Christmas after being worked for a year, the grounds assigned being that the lode "pinched out"; but it can confidently be expected to "make" again on further sinking.

(ii.) Sunnyside.—This was the first of the present leases to be taken up, its area being 160 acres. Beck's shaft is on the top of the ridge, a quarter of a mile north-west of the Mount Mudloo workings. This shallow shaft was abandoned a couple of years ago; nothing but a few copper stains on a fissure dipping N. 15 degrees E. can now be seen. It is said that the ore was in the form of a bunch. The country is syenite, intrusive between the granite and slates.

In the granite further west there is a lode from 1 to 2 feet thick of cellular iron-stained quartz, with a faint staining of azurite, and it strikes and dips in the same direction as the Mount Mudloo lode, of which it may be a continuation.

Another lode has been exposed in a pothole in the south-western portion of the lease; it consists of about a foot of gossan powder with a quartz leader and 3 feet of copper-stained formation, in which are quartz veins up to 6 inches in thickness, carrying both iron and copper in oxidised forms. The copper is not present in sufficient quantity to form a workable ore.

(iii.) White Rocks.—This lease, having the same area as the Mount Mudloo, adjoins the Sunnyside at the opposite end, and the most westerly workings (Baker's) are about 1½ miles from Mudloo House. An adit has there been driven about 20 feet along a quartz reef, which, halfway in, opened out to about 12 inches, but from that tapered down both ways to about an inch in thickness. The quartz is not only stained by carbonates, but carries grey ore (sulphantimonide) and oxides. Of course, the best ore has been sent away for reduction, but the nature of that left would not indicate great improvements on further exploitation. The country is granite porphyry.

In the granite, a few chains east of these workings, is a north and south dyke of coarse syenite, on both sides of which are small copper-bearing leaders. The felspar of the syenite is in places replaced by malachite, and secondary hæmatite occurs in bunches with it. The granite country near the leaders referred to is decomposed and similarly impregnated. To the south the granite becomes finer, almost felsitic in texture, and is there much fissured, the fissures being stained with carbonates of copper, but the percentage of the metal in the rock is not sufficient to pay for exploitation.

The latest workings are in about the centre of the lease, where a tunnel, 50 feet long, has been opened in decomposed granite. It was intended to cut, at about 200 feet, a reef which is exposed in a pothole, on the hillside above, and to the south, and which consists of 5 inches of solid iron and copper stained quartz, and 1 to 12 inches of intermixed quartz and country rock; the whole dipping very steeply to the south. The quartz carries much crystallised hæmatite, with a fair amount, up to perhaps 30 per cent., of copper carbonates, and the reef is on the junction of two granites, differing slightly in acidity.

Within a quarter of a mile to the east of the above are several old shafts, one of which, 20 feet deep, is on a 6-inch quartz leader, carrying a small amount of copper pyrites, and carbonates. The reef is seen to pinch out in the bottom of the shaft.

5.—Mines outside the Fields.

I.—TEEBAR COPPER MINES.

These are about 2 miles south of the Boompa Railway Station. They have long ceased to be worked, but are mentioned here because of their occurrence in granite, much of the felspar of which has been stained by copper carbonates in a similar manner to that at Mudloo; and possibly by solutions percolating downwards from slates since denuded.

II.—MUNNA MINE.

The Munna Mine is situated on portion 167, Marodian, on the road from Gigoomgan to Marodian Head Station, and the country rocks are altered limestones and slates of Gympie age; but granite outcrops within a few chains to the west.

The limestones have been partly altered into wollastonite, garnet, &c., as a result of the intrusion of the granite, and they are in places strongly impregnated with bornite.

Work was begun for copper many years ago on a lode about 2 feet thick dipping to the north-east. It was abandoned after a small amount of exploitation had been done. A few years ago a rich 1-inch gold-bearing leader was worked, but the mine has now been idle for a couple of years.

An underlie shaft has been sunk to a depth of 190 feet, and a level opened at 50 feet from the surface.

III.—CALGOA MINE.

The principal workings are situated on Thunder Creek, one of the head branches of Calgoa Creek. (See Map 1.) The mines are:—The Louisa (No. 1456), the Louisa No. 1W. (No. 1393), the Lug-e-nor (No. 1415), and Knight of Gwyn (No. 1419). These are all freehold lands, and the workings are all within a couple of hundred yards of the junction of slate and granite.

The ore deposits at Thunder Creek are not of the same class as those at Mudloo, that is to say, they seem to owe their copper contents either to the granite itself, the diorite, or to a deep-seated source, rather than to a former covering of volcanic strata.

(i.) Louisa.—Portion 1456 is at present held on tribute. Chiefly prospecting operations are being carried on and numerous shallow shafts have been sunk in granite country. One, known as the Mundic, is 30 feet deep, on a lode varying between 3 and 12 inches in thickness To a depth of 20 feet, the ore consisted of copper-stained gossan, then, for 4 feet, of pyrite with scarcely a trace of copper, but below that the copper has been continuously increasing in amount. The last 2 tons of ore from the shaft ran 10 per cent of copper, and the ore also carries traces of gold and silver.

At the main shaft, near the southern boundary of the lease, the country is pink granitite, and the lode which is 3 feet wide with good walls, and dips 1 in 3 vertical to the south-east. There does not appear to be more than 1 per cent. of copper carbonate in the ore as a whole, though the strains are much heavier in the fluean on the hanging-wall. The amount of copper will probably increase with depth.

(ii.) Louisa No. 1 N.—There are several inaccessible shafts on this property, and the positions of the lodes are shown on the accompanying map.

(iii.) Lug-e-nor.—Of the work done about thirty years ago most was on portion 1415. An adit was driven for 100 yards in quartz diorite, along a strong copper-stained fissure, on one side of which, at intervals of about a chain, are cross-fissures. Copper deposits were found on these cross-fissures for distances of about 10 yards from the main fissure (see Fig. 1), and when a bunch of ore had been worked out the main fissure was followed till another cross-fissure and deposit of ore were found. The quartz diorite is intrusive in slates. Mr. Allen, who is prospecting in the neighbourhood, pointed out the character of the lode to me.

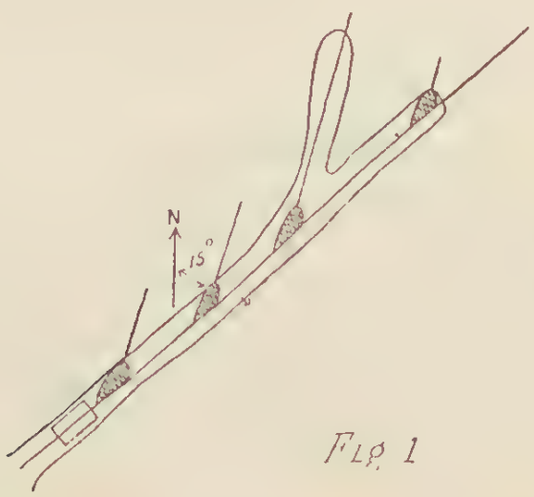

Fig. 1

Ore Deposits in the Lug-e-nor Tunnel.

(iv.) Knight of Gwyn.—No. 1415 is on the left side of the creek, about a mile above Calgo Creek, and is the most northerly of the big mines.

On the southern boundary there is a shaft on a lode in granite, within 5 chains of slates, and this shaft is 25 feet deep. The lode, which consists of a soft gossany ore, with strings of carbonate and red oxide ore, varies from 6 to 18 inches in thickness.

Within a quarter of a mile west of this are numerous very promising gossan outcrops, generally striking north-west, and in or near dykes of quartz diorite. One, exceptional in striking east and west, and in being in slate country, is about 3 feet in width. The ore is reported to have run 10 per cent. of copper, and the lode has in past years been extensively worked above the water level.

6.—Conclusions.

It has been shown that the Yorkey's mines are now passing out of the hands of prospecting syndicates into those of companies. The reefs are not large, nor are they high grade, but, as described, the Surprise, Zealandia, Triad, and Beer and Dawson's should prove payable.

The Colo Gold Mine and the Mudloo Copper Mines are only in the prospecting stages. So little is to be seen that nothing favourable can be said of the Mudloo copper deposits, as a whole. The northern lodes at Calgoa have a much more promising appearance.

My special acknowledgments are due to Mr. Newton, the manager of the Triad, for his aid at Yorkey's and for plans of the Triad and Zealandia and of the various leases.

Appendix 1.

MOUNT COLO MANGANESE DEPOSITS.

Manganese dioxide occurs on a razor-back, half-a-mile west of Mount Mona, in the north-eastern portion of the goldfield. (See Map 1.) It is there interlaminated with, and replacing, red jasperoid slates, over an area of a few square yards. The laminations vary from one-eighth up to two inches in thickness.

Its chief occurrence is near the summit of Mount Colo, on the eastern and southern flanks of which traces of the ore can be found over a comparatively large area. Very little work has been done, and that was not in search of manganese ore.

A 2-feet band of chalcedonic quartz, with veins of mammilated psilomelane, up to 6 inches in thickness, has been opened. It probably represents replaced red jasperoid slates, a belt of which extends from Mount Colo to Mount Mona and beyond. These slates have, further east, been replaced in great part by quartz, which has first filled minute crevices and then metasomatically replaced the actual rock. Specimens showing all stages of the process can be collected.

Prospecting operations may yet prove deposits of workable thickness in this locality.

Appendix 2.

EXCEPTIONAL MINERAL OCCURRENCES.

Filly Flat, Mineral Selection 1822, Marodian.—The country here consists of Permo-Carboniferous slates and limestones, dipping north-east. The limestone must originally have been very impure, such as that at Gigoomgan Head Station. It is much altered, having a great development of opaque dodecahedral crystals of garnet, slight stains of copper carbonates, and impregnations of copper sulphide. In places there are bunches of garnet, wollastonite, erubescite, olivine, &c.

At the Munna Mine the limestones have been altered in a similar manner, but they contain no olivine.

Yorkey's Surprise, Yorkey's Gold Field.—Another unusual occurrence is that of garnet, epidote, actinolite, and calcite, forming a fissure vein in the diorite country on the Surprise lease, west of the main workings.

Ortt's Lease, Yorkey's Gold Field.—The occurrence of plentiful hæmatite and rhombohedral calcite, in a quartz fissure, in diorite country is also uncommon.

Appendix 3.

MINERALS AND LOCALITIES.

Actinolite: Mount George (Yorkey's); "Surprise."
Ankerite: Lease 2682, Kilkivan.
Arsenopyrite: Yorkey's.
Barytes: Portion 648, Marodian, half-mile east of Burnside.
Blende: "Beer and Dawson's"; Rise and Shine (Kilkivan).
Bornite: "Mount Ruby," Glenbar; Calgoa; Munna Mine; Mudloo.
Calamine: "Beer and Dawson's."
Cervantite: "Zealandia."
Chalcopyrite: Mudloo.
Cinnabar: Lease 2682, Kilkivan.
Copper, Native: "Mount Mudloo."
Cuprite: Munna Mine.
Galena: "Beer and Dawson's"; "Mount Mudloo."
Garnet: "Mount Ruby"; Filly Flat; Munna Mine; "Surprise,"
Grey-ore (Tetrahedrite): Mudloo.
Hæmatite: Mudloo; "Silver" Mine; Campbell's and Ortt's; Selection 1346, Gigoomgan.
Jasper: Mount Mona; Mount Colo; Running Creek.
Magnesite: Kilkivan.
Olivine: Filly Flat.
Psilomelane, Pyrolusite } Mount Colo; Mount Mona.
Pyrites: "Yorkey's; "Beer and Dawson's."
Stibnite: "Triad"; "Surprise."
Wolfram: "White Rocks" (?).
Wollastonite: Filly Flat; Munna Mine.

Appendix 4.

PETROLOGICAL NOTES.

Spec. 31.—Quartz diorite.

Loc.: Half-a-mile south of Mudloo House. Dyke in granite.

Macro.: Rough speckled (brown and green) base with porphyritic quartz and felspar crystals, which weather in relief; the quartz having a red coat. This is the typical dyke rock in the Mudloo district.

Micro.: Microcrystalline base, with a faint fluxion structure, composed of short laths of a very acid plagioclase, with large angular grains of quartz; the latter are not corroded, but are surrounded by a dark zone of fibrous, radiating, epidote, which mineral, with chlorite, also occurs throughout the base and represents decomposed hornblende. Magnetite is not abundant.

Spec. 55.—Amygdaloidal olivine andesite.

Loc.: Railway cutting about $\frac{1}{4}$-mile west of Kilkivan. Specimen occurs as fragments in a breccia, which is plainly interbedded with serpentine slates. It proved the interbedded nature of many rocks outcropping further west.

Macro.: Dark reddish brown minutely vesicular (amygdaloidal) very fine-grained rock.

Micro.: Microcrystalline base, with fluxion structure. Vesicular throughout, the vesicles being sometimes partly or wholly filled with spherulitic amygdaloids. The minerals are much altered; the felspar laths, which are often in radiating groups, are only skeletons; and the ferro-magnesian mineral is replaced by viridite and magnetite. Magnetite also occupies all cracks, forming a rectangular network, and gives the section its dark appearance. One or two perfect casts of large olivine crystals are filled with magnetite, hæmatite, and viridite. Epidote, calcite, and viridite occur as amygdaloids.

Spec. 66.—Hornblende andesite.

Loc.: Boonara road, $8\frac{1}{2}$ miles west of Kilkivan, on the eastern fall of the Boonara Range. Interbedded in serpentine slates.

Macro.: Rough, red, microcrystalline rock, with recognisable felspar and hornblende.

Micro.: Microcrystalline with fluxion structure, and a devitrified spherulitic base. Numerous small crystals of light brown amphibole, large altered grains and zoned crystals of plagioclase, much epidote and magnetite, but still more hæmatite. There is also present a little whitish pyroxene.

Spec. 100.—Rhyolite.

Loc.: The Falls, Yorkey's Creek, Marodian Gold Field. Dykes in slates.

Macro.: White and fine-grained, but rough to the touch, showing a definite fluxion structure, causing portions of the dyke to appear to be made up of concentric coats; a few small phenocrysts.

Micro.: Cryptocrystalline, felsitic (devitrified), base without perceptible fluxion structure, but imperfectly spherulitic in parts. There are a few small porphyritic crystals of orthoclase and plagioclase and some secondary calcite.

Spec. 111.—Augite diorite.

Loc.: 380 feet level, Scottish Marodian. Country rock, forming part of the same mass as specs. 114 and 146.

Macro.: Black, almost granitic, rock, in which felspar, hornblende, and biotite can be recognised.

Micro.: Granitic; fresh idiomorphic plagioclase, sometimes bent, broken, and split; idiomorphic augite, much twinned; and a little allotriomorphic biotite. Quartz in small quantities fills the interspaces among the felspars. There is a small amount of comparatively course magnetite. (Magnetite and biotite are very probably secondary after augite.) A few topaz grains and apatite rods are to be seen.

Spec. 114.—Silicified diorite.

Loc.: Well shaft, Benson's, Yorkey's Gold Field. Belts in the ordinary diorite.

Macro.: Almost pure white finely crystalline rock, which passes suddenly, within ¼-inch, into the ordinary diorite.

Micro.: Almost an aplite in appearance, but really an altered diorite impregnated with secondary silica, which often has a graphic structure. Hornblende is chiefly altered into green hydrous mica, the felspar is kaolinised, and magnetite is nearly absent.

Spec. 146.—Quartz diorite.

Loc.: In Running Creek, 2 chains north of the southern boundary of Yorkey's Gold Field. Gradually passes into the ordinary diorite country of the goldfield.

Macro.: Black granitic rock, in which felspar, hornblende, biotite, and quartz can be recognised. The section proves the diorite here to be more acid than that to the east and north-east.

Micro.: Granitic; chiefly plagioclase (some zoned), with primary biotite quartz and a few grains of altered hornblende and crystals of twinned augite. Much secondary mica. Large needles of apatite and a few grains of topaz.

Spec. 154.—Olivine andesite.

Loc.: Alma Creek, about 2½ miles above Fricke's Selection. Interbedded flow in slates. Weathers exactly like a conglomerate.

Macro.: Fine-grained, brownish base, in which felspar laths and phenocrysts alone can be recognised.

Micro.: Glassy base, with very minute oriented felspar laths, plagioclase (labradorite) and augite phenocrysts, and a fair sprinkling of magnetite, with stains of hæmatite. There are a few large olivine crystals, which are chiefly altered into serpentine and magnetite.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND

MAP 1

YORKEYS & MARODIAN GOLDFIELDS

AND THE COUNTRY IN THE VICINITY.

To Accompany Report

BY

LIONEL C. BALL, B.E.,

ASSISTANT GOVERNMENT GEOLOGIST

1902.

SCALE 1 Mile to an Inch

Drawn by A. McLaren at the Geological Survey Office Brisbane

INDEX TO COLOURS

- F? Permo-Carboniferous (Gympie ?)
- G Granite
- Di Diorite
- J Burrum

SECTION ON THE LINE A.B.

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND

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G Granite
D Diorite
F Gympie Formation
Dykes (Arrow denotes direction of Dip)
Shafts

19v
20v
21v
8v
649
1684
G
G?
Gr of Di?
Di
F
Slate
Tuff Slate
Quartz Diorite
Felsitic Slate
Numerous Dykes
Ellery's Shaft
Felsite Dyke
DYKE
DYKES
DYKE ?
Porphyrite Dyke
Foliated Felsite Dyke
Reef
Waratah Lode
WARATAH
M.C. ORTTS WARATAH
TRIAD EXTENDED
Triad Lode
LAKE VIEW CONSOLS
Reef
Porphyrite Dyke
BEER & DAWSON
Slate
Quartz Veins
Clay Slate
NEWTON'S
HUT
McLEAN'S LEADER
YORKEYS
Quartz, Calcite, Garnet, Haematite & Copper
Silicified Diorite
Epidote bearing Dyke
Haematite bearing vein traces of Copper
Old pot hole
NO WEST
SURPRISE
ZEALANDIA
Compound Andesite, Quartz Diorite & Porphyrite Dyke
Di Dyke
Quartz
Di Dyke
Porphyry Dyke
Running
SCOTTISH MARODIAN
SCOTTISH MARODIAN
Augite Diorite
M.C. ORTT
CAMPBELLS
Hornblende Granite
Foliated Felsite Dyke
G. Porphyry Dyke
TO MUDDOO
TO KILKIVAN
Forest Ck
Ck

MAP 2
YORKEYS GOLDFIELD
AND VICINITY
To Accompany Report
BY
LIONEL C. BALL B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.
1902.

Scale 20 Chains to an Inch
20 0 20 40 60
A McLaren Del.

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.

VICTORIA.

Queensland

DEPARTMENT OF MINES

GEOLOGICAL SURVEY REPORT No. 180.

REPORT ON A VISIT TO THE WEST COAST OF THE CAPE YORK PENINSULA AND SOME ISLANDS OF THE GULF OF CARPENTARIA

ALSO

REPORTS ON THE HORN ISLAND AND POSSESSION ISLAND GOLD FIELDS, AND THE RECENT PROSPECTING OF THE CRETACEOUS COALS OF THE COOK DISTRICT

BY

C. F. V. JACKSON, B.E., Assoc. M. Inst. C.E.
ASSISTANT GOVERNMENT GEOLOGIST

BRISBANE:
BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1902.

LETTER OF TRANSMITTAL.

Geological Survey Office,
Brisbane, 7th November, 1902.

Sir,—I have the honour to submit for publication my report on a visit to the west coast of the Cape York Peninsula and some islands of the Gulf of Carpentaria; also reports on the Horn Island and Possession Island Gold Fields, and the recent prospecting of the Cretaceous coals of the Cook district.

The first report deals with an examination of the coast lands of the Gulf of Carpentaria and the South Wellesley Islands, and furnishes information which will enable additions and corrections to be made to the geological map of the State.

The two following reports bring our information up to date with regard to the condition of mining at the Horn Island and Possession Island Gold Fields, and the last report deals with the progress of the search for coal in the Cook district.

Twelve plates and four maps are in course of preparation for this report, which will be No. 180 of the Geological Survey publications.

I have, &c.,
C. F. V. JACKSON,
Assistant Government Geologist.

To the Under Secretary for Mines,
Department of Mines, Brisbane.

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GEOLOGICAL SURVEY OF QUEENSLAND.

Scale 68 Miles to the Inch.

GULF OF CARPENTARIA

TORRES STRAIT

MULGRAVE I
BAKKS I
WEDNESDAY I
THURSDAY I
HORN I
PRINCE OF WALES I
C York
Endeavour Strait
POSSESSION I
NEWCASTLE B
JARDINE R
ORFORD
Vrilya P
McDonnell Tele Stn
PORT MUSGRAVE
Tullanaringa
(Cullen Pt)
Skardon C
OULHUNTY R
RICHARDSON R
SHELBURNE BAY
MAPOON MISS STN
DUCIE R
BERTIENHAUCH
PENNEFATHER R
BATAVIA R
Moreton Tele Stn
MISSION R
YORK DNS STN
Duyfhen Pt
ALBATROSS BAY
Pera Head
EMBLEY
Weipa R
MISSS Stn
WILKINSON R
False Pera Head
Mein Tele Stn
ARCHER R
OR PEACH R
COEN R
ROKEBY OLD STN
Cape Keerweer
(or Turnagain)
McLEOD R
ROCKY C
KENDALL R
HOLROYD OR LUKIN R
EDWARD R
GOLEMAN R
ALICE R
MITCHELL R
NASSAU R
ROCKY C
WELLESLEY ISLANDS
MORNINGTON I
Cape Van Diemen
Lagoon C
STAATEN R
pr Bayly
pr Parker
BENTINCK I
VAN DIEMEN R
Sth Mth Gilbert R
SWEERS I
FOWLER I
Investigator
pr Tarrant
Cliffdale
Moonlight R
Kangaroo Pr
pr Gore
FLINDERS R
NORMAN R
GILBERT R
Walkers C
KARUMBA
NORMANTON
EINASLEIGH R
BURKETOWN
NICHOLSON R
GREGORY R
BARCLAY R
ALBERT R
Floraville Tele Stn
ALEXANDRA R
Nulbuinmoo
DYNOE R
GARRON R
CROYDON
YAPPAR R
CLARA R
NORMAN R
Elizabeth C
Sth Esk or Lawn C
Archie C

By Authority: G. A. VAUGHAN, Government Printer, William street, Brisbane.

REPORT ON A VISIT TO THE WEST COAST OF THE CAPE YORK PENINSULA AND SOME ISLANDS OF THE GULF OF CARPENTARIA.

Acting on instructions to accompany the Northern Protector of Aboriginals, Dr. Roth, on a visit to the more remote parts of his district, I left Brisbane on the 22nd April and arrived at Thursday Island on the 1st May.

After a few days had been spent in necessary preliminary arrangements, the Government yawl "Melbidir," about 25 tons burthen, with the party on board, left Thursday Island on the 3rd for the west coast of the Peninsula; and arrived on the 6th at Mapoon Mission Station, which is situated at the mouth of the Batavia River and on the southern head of Port Musgrave, a fine harbour about 80 miles south of Cape York. (*See* Map, page 6.)

The portion of the coast north of the Batavia River for about 60 miles is known as the "Seven Rivers" district, and with the exception of Vrilya Point, which is the only prominent feature between Port Musgrave and the north-west corner of the peninsula, the whole of the land surface along the coast is characteristically low-lying and sandy.

On the State geological map the Desert Sandstone rocks (Upper Cretaceous) are shown to extend right across the Peninsula in this latitude, and the same formation, save for a small area of older rocks—quartzite, &c.—in the vicinity of Peak Point, stretches southward to the Mitchell River, a distance of nearly 400 miles.

It forms the coast line on the west as far as the Archer River—170 miles—and on the east as far as the southern side of Temple Bay, the south head of which is formed by the northern extremity or apex of a wedge-shaped area of granitic rocks, which extend south to Princess Charlotte Bay.

At Vrilya Point the cliffs are nearly 80 feet above sea level; they present a vertical escarpment for the upper 15 or 20 feet, and slope then more gently to the base, this lower portion being composed of a very coarse and crumbling brown sandstone.

The upper portion has been laid down in a much finer-grained and more argillaceous form which is very ferruginous, and for a thickness of 15 or 20 feet below the top of the cliff, has formed into a deposit of somewhat clayey pisolitic ironstone or iron ore.

This bed of pisolitic ironstone forms the steep escarpment of the upper portion of Vrilya Point and of the coast for some distance to the north; and is similar to the deposits which outcrop further south at the Batavia and Embley Rivers, the characteristics of which are described below.

Between Vrilya Point and the Batavia River the coast land, which is very low, trends away to the east.

At Port Musgrave a hospitable welcome is received at the Presbyterian Mission Station, conducted by the Rev. Mr. Hey; "Mapoon," which is on the southern head of the harbour, Tullanaringa, or Cullen Point. Here there is a native school, and there are several hundred aboriginals in the settlement, for whom employment is found in the bêche-de-mer and pearl fisheries, as well as at the station itself.

There are but few outcrops of rock near the mouth of the Batavia River, and the strata cannot readily be observed, but at the lowest tides a débris of

ferruginous sandstone forms a shingly beach. Occasionally a portion of the formation can be seen *in situ* forming a reef of rocks, but it is elsewhere covered by a recently formed drift of sand and fragments of shells, which in many places can be seen forming into a calcareous sandstone. The formation again appears in the form of ferruginous sandy clays on the southern side of Port Musgrave, 3 miles from Mapoon; and on the south shore of the Batavia River 7 miles from the station, where the cliffs are from 25 to 30 feet high, a deposit of clayey pisolitic ironstone similar to that at Vrilya Point is seen overlying these clays.

It is here from 6 feet to 8 feet in thickness, and presents a vertical face for nearly a mile along the river, but beyond that is obscured by a dense forest of mangroves; masses of the débris form the shore and slope of the river bank. (Plate I.)

The country in the vicinity of Mapoon is low and swampy, and the station is situated on a comparatively well-timbered sandy flat, with sand-dunes frequently occurring along the seaboard: in fact, a similar description applies to the visible portion of the coast from Vrilya Point southward to Duyphen Point, which is the northern shore of Albatross Bay; and between these two points the western escarpment of the Desert Sandstone lies some distance east of the coast line. On reaching Albatross Bay the Desert Sandstone rocks are again seen at Point Kerr just inside the bar at the mouth of the Embley River, which is here a fine broad expanse of water, though very shallow in places; probably, however, a channel of 2 or 3 fathoms would be found on surveying the entrance.

From this estuary the Hey River takes a south-easterly course, and the Embley River a more easterly direction.

Weipa Mission Station is situated on the latter about 22 miles from the coast. From the mouth of the river both shores are screened by a dense mangrove scrub covering mud flats of considerable area, but at the junction of the Embley and Hey Rivers, 5 miles from the coast, low red cliffs composed of the ferruginous sandy clays of the Desert Sandstone, are to be seen behind the fringe of mangrove scrub.

After leaving the river bank the country becomes rather swampy and low-lying.

On the south side, about three-quarters of a mile from the shore, are some remarkable midden heaps of great size. (Plate II.)

These accumulations, a series of heaps and mounds from 20 to 30 feet in height and stretching for several hundred yards, are composed chiefly of the shells of cockles, oysters, and other edible molluscs, the most abundant being that of Arca Granosa.

Proceeding up the Embley River, the banks on either side are to a great extent obscured by a dense fringe of mangrove scrub, many of the trees being remarkably tall and straight; and the river becomes rapidly narrower.

At about 17 miles from the junction on the north side is the Weipa Mission Station, a more recent sphere of mission work; and the river has there a width of not more than about 70 yards.

It had been arranged to travel inland from this point, and after horses and the necessary equipment had been procured, the party left for Moreton; a station on the Cape York telegraph line situated near the centre of the peninsula.

In the vicinity of Weipa the country has a generally level surface, and a series of flats and swamps extend as far as the low sandstone range about 8 miles to the east: rather ferruginous sandstone is to be seen here and there and among the intricacies of the swamps between the Embley and Mission Rivers outcrops of brown pisolitic ironstone.

Débris of Pisolitic Ironstone, South Shore, Batavia River.

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REMARKABLE MIDDEN HEAPS, AT JUNCTION OF EMBLEY AND HEY RIVERS.

The frequency of occurrence of this pisolitic iron ore leads one to believe that the deposit extends more or less continuously northward to the north point of the peninsula; where several small areas were noted by Mr. Jack between the Jardine River and Escape Inlet.

Pisolitic iron ores, and Bauxites to which they are closely related, are not infrequently of some commercial importance, suitable varieties of the former being valuable as fluxing ores; the latter is a source of metal aluminium.

Beds of this description are, geologically speaking, never very old, the oldest being interstratified with Cretaceous Rock. Those in the York Peninsula occur in association with rocks of Upper Cretaceous age. Such deposits may be primarily tuffaceous, but in the York Peninsula I could find no evidence pointing to other than sedimentray origin.

The mass of the ironstone or ore at the Batavia River and elsewhere is composed of a number of rounded grains imbedded in an earthy groundmass, and varies in colour from a light yellow to a chocolate brown, the colour being dependent on the quantity of iron present. (Plate III.)

An analysis of some of the specimens collected did not give very good results, thus—

Specimens.		Moisture.	Silica.	Iron.	Alumina.
Clay associated with ore	Specimen from Vrilya Point	2·89	32·64	16·0	28·18
	Specimen from Batavia River	2·23	42·53	6·72	33·35

But I think it probable that if these deposits were systematically examined and sampled, they would be found to include masses of higher-grade ores; and, if such were the case, they might ultimately prove of some value, especially on account of their ready accessibility from the sea.

The areas over which they are distributed are easily recognised, as the hard ferruginous concretions comprising the mass weather out, and the surface of the ground becomes strewn with small round ironstone pebbles, the size of a pea.

The low range dividing the Embley and Mission Rivers is composed of a dark-coloured sandstone, which, though part of the same great formation, is very different in its lithogological characteristics to the Desert Sandstone of the western portion of the State. The rock is a coarse-grained quartzose variety containing pebbles of quartz, and in some places is a fine conglomerate.

Between York Downs Station situated near the head of the Mission River, and the Moreton, the country is almost quite flat and marshy, and the elevation dividing the waters of the Mission River and Cox Creek is scarcely perceptible.

Between Cox Creek and Moreton are several large creeks which are not marked on our map. Moonlight Creek, a fine large creek with good permanent water. was crossed at about 7½ miles, and another of equal magnitude about 9 miles from Cox Creek, both are, no doubt, tributaries of Cox Creek.

The Moreton Telegraph Station is on the Batavia River about 45 miles east-north-east of Weipa.

The rock exposed in the bed of the river in this locality is somewhat clayey, containing in places a good deal of iron oxide, which gives it a red and white appearance, and the sandstone has all the characteristics commonly observed in many beds of the Desert Sandstone series.

For 30 miles north of Moreton, towards McDonnell Telegraph Station, there is very little change in the general appearance of the country; a gently undulating surface with patches of thick scrub and tea-tree flats. Outcrops of rock, where occasionally seen on the ridges and in the creeks, consist of a fine-grained ferruginous variety of sandstone belonging to the upper beds of the formation.

South from the Moreton the track along the telegraph line crosses a series of ridges and swamps; the latter being very boggy and treacherous in wet weather, and the surface is covered by a thick coarse grass some 6 feet or 8 feet in height.

On the higher ground in many places considerable areas of the surface are covered with small rounded boulders or pebbles, extremely hard and quartzitic in appearance, and probably derived from the débris of an upper bed identical with the siliceous rock found capping the formation in the Western portion of the State, where its remains are so frequently seen in a similar manner. About 4 miles to the south of Moreton is an outcrop of very fine-grained clayey sandstone, the prevailing colour being white, but in places it has become coloured, a light red or pink, by the formation of oxide of iron with apparently a concretionary tendency.

The lithological character of this rock is identical with that of the beds which are found overlying the opal-bearing sandstones of the Western tablelands, and which is there so frequently found converted into porcellanite. The rock forms a bed about 20 feet thick, capping a low ridge, and beneath it is the prevailing coarse sandstone of the district.

It has been found to contain common opal in places, and fragments of the rock have been picked up on the ridge with veins of a resinous variety of this mineral filling small cracks and joints. Some specimens from the ridge were given to me by Mr. Lindeman, the officer in charge of the telegraph station; but I was not able to find any opal *in situ*. No precious opal has been found in the formation.

Proceeding south the road continues over the Desert Sandstone formation, crossing the Wilkinson Range about 12 miles from the station. About 8 miles south of Mein Telegraph Station (56 miles south of Moreton) the telegraph line takes a more south-easterly direction, crossing the eastern boundary of the sandstone, and passing on to granite.

This large area of Desert Sandstone, which forms the greater part of the Cape York Peninsula, was traversed by Mr. Jack in 1879-1880 along its eastern boundary, which was found to follow approximately the 143rd meridian to the point where it cuts the coast line in Temple Bay. He thus describes the formation on the east:—

"The sandstone at its eastern escarpment had a thickness of about 50 feet, and was about 200 feet above the level of the plain. It was ferruginous and very hard, and appeared to be partly composed of a fine volcanic dust. It contained little pebbles of quartz and larger pebbles of slate and quartzite.

"Between Canoe Creek and the Pascoe River outliers of Desert Sandstone rest on the top of granite hills, and the escarpment, which prolongs the Geikie Range to the north, continues in an unbroken line.

"Far to the west, the eastern escarpment of the tableland forming the watershed between the Batavia (Gulf waters) and the Pacific waters at the heads of the Pascoe, a second escarpment marks the eastern limit of a higher bed of Desert Sandstone—Wilkinson's Range."

These beds forming the Wilkinson Range appear to belong to the same horizon as the uppermost beds of the series forming the Western tablelands.

PISOLITIC IRON ORE FROM BATAVIA RIVER.

VICTORIA

Mr. Jack also stated that it was probable that the formation had a gentle dip from the Eastern escarpment, where he found it bare at a considerable altitude to the coast of the Gulf of Carpentaria; and this assumption appears fully borne out by examination of the formation along its western margin. Though the greater portion of the peninsula is covered by part of the same great formation which gives rise to the barren mulga ridges, and produces in weathering the isolated flat-topped hills which form the characteristic scenery of Western Queensland: on this more northerly situated area of the formation, where other conditions of weathering exist owing to the regular and comparatively large annual rainfall (55 inches), the aspect and appearance of the country is entirely different.

The country, moreover, is well timbered with the usual varieties of Eucalyptus, tea-tree, &c., the latter of very larger size; and the surface as a rule is luxuriantly grassed. It is somewhat surprising that the country is not more largely availed of for grazing purposes.

The party returned to Weipa and left for the Mitchell River on the 25th of May, reaching there on the evening of the 28th.

The Bishop of Carpentaria, who accompanied us, was desirous of examining the Mitchell River country, with a view to establishing a mission station, and as the natives are in considerable numbers in the neighbourhood, and quite uncivilised, a police patrol in charge of Inspector Garraway had been despatched from the Laura, the terminus of the Cooktown Railway.

It had been arranged to meet on the 28th at the Mitchell River, and that a short tour inland from the coast should be made. Unfortunately, however, the overland party were nowhere to be seen on the date agreed on, and owing to the fact that the Mitchell River breaks through to the coast at several different places with some 6 or 7 miles between, there was some doubt on our part as to which of the several mouths of the river they would reach on their overland journey. It was accordingly thought advisable, after having landed for a short time, to return and search along the coast, but after proceeding to the most northerly and southerly mouth of the river, and landing at several places, no sign of the police party was discovered. The ship's supply of water was very short, and on the 1st June the time at our disposal was exhausted, the vessel being due at Normanton; hence the opportunity was lost of examining the country inland from the coast. Subsequent information from Inspector Garraway showed that his party had arrived on the morning of the 1st, and actually saw the vessel leaving; but though signals were made, they were rather far off to be discerned by those on board.

The coast land in the vicinity of the Mitchell River is very low and sandy, and during exceptionally high tides a considerable area of it must still be subject to inundations by the sea. It is covered chiefly with mangroves of several species and a coarse running grass which is common in many parts of the East coast. The surface is composed of a loose sand, chiefly made up of the fragments of recent shells.

The same flat sandy country forms the western margin of the peninsula from the Archer River to Normanton, and the coast presents one long low unbroken line. It is quite devoid of any prominent land marks by which one part may be distinguished from another, and cannot be discerned from the deck of a vessel at a distance of 6 miles.

A closer inspection reveals a timbering of mangroves, with here and there a few straggling casuarina trees. The coast line is also seen to be broken by a number of creeks and small openings. Mud flats covered only at half-tide stretch out for a considerable distance, and the water is very shallow even at 5 or 6 miles from the coast, where the soundings are often not more than 3 or 4 fathoms.

This eastern shore of the Gulf of Carpentaria is believed to have been the first portion of the Australian coast visited by the Dutch, between the years 1606 and 1623.

They proceeded at least as far south as latitude 17 degrees, naming Van Dieman's Inlet, Duyphen Point the north head of Albatross Bay, and a small inlet between the north and south mouth of the Gilbert River

The first British survey was made by Flinders in H.M.S. "Investigator" (1802).

Some outcrops are to be seen at Karumba, at the mouth of the Norman River, and the rock consists of a recently formed fragmentary deposit of shells and sand, forming a kind of shell limestone. (Plate IV.)

The area occupied by the formation is about 8 square miles, and there is an area of equal extent on the south side, about 8 miles further up the river.

It is to be noted that this deposit has hitherto been mapped on the State geological map as of Lower Cretaceous age, and a correction is to be applied accordingly.

Between the Norman and Albert Rivers the water is extremely shallow, and submerged mud flats extend for 10 miles, with a sounding of only about 3 fathoms; the water has a brown, muddy appearance, and during the north-west monsoon these shallows are productive of a dangerous sea.

The shore is protected by a dense fringe of mangroves, and behind this barrier, in the vicinity of the Albert River, are vast salt pans and marshes, which stretch as far as Burketown some 20 miles.

The influence of the mangroves on the history of much of the coast land of this portion of the Gulf is very striking.

This singular and most important of our swamp-breeding trees furnishes an interesting example of a plant having become highly specialised with reference to peculiar conditions, not only in the physiological modifications, which enable the living plant to endure the salt water, but in many of its structural features. The seed, which attains an unusual measure of development before it is detached from the parent tree, is peculiarly adapted for the conditions of its germination.

As the mangrove usually stands amid water, most of the seeds when dropped come under the influence of wind and tidal currents. They are fusiform bodies, and when floating, owing to the difference of weight of the two extremities, they lie in a nearly vertical attitude; the sprout end upward, not much below the surface, and downward the basalar or root end, which after a time, owing to the peculiarities of its form, becomes caught on to the bottom, roots being thrust out to attach it more firmly and stimulate further development of the plant.

Under favourable conditions, as soon as the mangrove is established along the shore, it spreads with great celerity, and its growth, particularly in the development of remarkable aerial roots, begins to serve in the formation of a barrier to the escape of land waters.

A gradual extension of the wood from the shore takes place, and the advance of the mangrove bushes over the sea-floor is only limited by the deepening of the waters and the action of the waves. The growth tends to check the flow of currents, bringing about a deposition of sediment; mud, shells, driftwood, &c., lodge in the interstices, and the dense mass of their roots and stems entangles decayed vegetation. The result is that a low rampart or mole is formed along the swampy shore and this acts as a tolerably effective barrier between the waters of the sea and those of the land. As the strip of mangrove gains on the sea, the inland part of the growth dies, because of its lack of contact with salt water, which appears essential for the development of this

SPECIMEN OF SHELL ROCK FROM RECENT DEPOSIT, KARUMBA, NORMAN RIVER.

NATIONAL MUSEUM

VICTORIA

RECENT CALCAREOUS DEPOSIT OVERLYING DESERT SANDSTONE, SWEER'S ISLAND.

plant, thus the barrier produced by the growth of these peculiar trees continually advances in its development on the sea-face, leaving on the land side a level swampy surface.

This effect of the mangrove growth, assisted, no doubt, by the gradual upheaval of this portion of the continent, of which there is abundant evidence, has given rise to large areas of low-lying salt-marsh country. Moreover, such a deposit necessarily contains a large proportion of salt, and quantities of this mineral, being dissolved by rains and surface waters and redeposited, form a thin crust over the surface, giving rise to the so-called salt pans. They are quite devoid of any form of vegetation.

In the slight depressions or shallow basins between the mouth of the Albert River and Burketown, considerable deposits of salt have taken place, which are increased to a certain extent after every rain by the addition of surface waters bearing more salt, which on evaporation crystallises out of solution and forms a clean deposit, sometimes several inches thick and several acres in extent.

The salt from the most conveniently situated of these deposits is occasionally collected commercially in the vicinity of Burketown.

This salt-marsh and salt-pan country has been found to occupy a large proportion of the lower coast land of the Gulf, stretching as far as the western boundary of the State; and except in certain small details and slightly inaccurate topography, the geological map of this somewhat unsurveyed district is substantially correct.

The Wellesley Islands lie to the north of Burketown; Sweer's Island, the most southerly, being about 28 miles, and Mornington Island, the most northerly, about 60 miles from the coast.

This group of islands was first visited by Flinders in H.M.S. "Investigator," when charting the Gulf waters in 1802, and subsequently more completely surveyed by Captain Lort Stokes in H.M.S. "Beagle," 1841.

Investigator Road, between Sweer's Island and Bentink Island, is the only anchorage for vessels of all sizes at the head of the Gulf in either monsoon, and is some 4 miles long by 1 mile in breadth, with a depth of from 4 to 6 fathoms.

For this reason and partly on account of the supposed unhealthiness of Burketown it was originally intended to establish here the port for the Gulf of Carpentaria; a Custom-house was built and the site of the proposed township of Carnarvon surveyed on Sweer's Island. The idea, however, has long since been abandoned.

Flinders obtained much-needed supplies of water by sinking a well on Sweer's Island, and left a record of his voyage by marking the name of the ship and date on a small tree, portion of which still remains at what is now known as Point Inscription. Unfortunately the limb bearing the original inscription no longer forms part of this historical tree, but has, I believe, been deposited in the Museum.

Sweer's Island (*see* Map No. 2) is about 5 miles in length, the most prominent feature being Inspection Point, a rocky cliff at the south end nearly 100 feet high. The rock forming this high land consists of a hard calcareous sandstone, which forms a bed some 60 or 70 feet in thickness, and weathers on the surface with sharp angular pinnacles or points.

The rock is of comparatively recent origin and composed of sparsely distributed quartz grains, small ferruginous particles, forams, and fragments of shells, the latter from which no doubt the cementing material was derived forming the greater portion of the deposit near its base. The same formation crops out in the bay to the north of Point Inscription on the north-west coast of the island, and in a slightly modified form along the west coast between Point Inscription and Point MacDonald.

After a gradual upheaval had elevated the basal portion of the island sufficiently for the formation of beach sands, partly from the material derived immediately from the shore rocks and partly from the coral and shell fragments, the prevailing winds picking up the surface particles from the seaward side whirled them further from the coast, where they were again deposited; the mass gradually became consolidated by the large proportion of calcareous and other cementing ingredients, and the entire ridge was thus built up. The base of this calcareous rock can now be seen some 30 feet above the level of the sea. (Plate V.)

Immediately beneath the deposit is a red-and-white clayey sandstone, and this latter formation, with the exception of the outcrops previously mentioned, and a small area of the more recent deposit on the south, forms the rocky shores of the remainder of the island.

Interesting evidence of aboriginal methods of fishing is to be seen at low tide at the south end, where large circular weirs or fishtraps are exposed, some of considerable size, built by the natives of the harder and more ferruginous portions of the clayey sandstone, and now cemented together by a growth of oysters and shellfish. (Plate VI.)

The surface of the island which is covered in many places by low sand-dunes is in general composed of the red soil and ferruginous débris of the sandstone.

The island is well-timbered in places and fairly well-grassed, and is stocked at present with some 500 or 600 sheep and a number of goats. This stock is the property of two or three men who reside on the island, and obtain supplies, &c., by occasionally visiting Normanton and Burketown. No natives have been known to visit the island for a number of years.

Bentink Island, which forms the western shore of Investigator Road, only 2 miles distant, is nevertheless inhabited by a considerable number of blacks, quite unused to outside associations. For this reason, after the vessel had been moved to a convenient anchorage, it was thought advisable for those landing to be provided with firearms, but the precaution proved quite unnecessary, and none of the party was successful in even catching a glimpse of the natives.

Smoke was seen towards the south end of the island but only some smouldering fires were found, and a large camp, evidently just abandoned on the approach of the party.

The condition and habits of the natives here are evidently of a very low order. They apparently have a number of camping-places in the vicinity of their different fishing-grounds, where from time to time they are located, and they live chiefly on fish which are speared at night by the aid of lighted torches. Dr. Roth informs me that it has not yet been ascertained by what means they procure this light.

Captain Stokes observed that their only means of crossing narrow channels to adjacent islands was by means of a rough raft of sticks, and no bark canoes were used as with the mainland natives.

Their habitations are extremely primitive, no covering of bark as used elsewhere being ever seen, and the camp consists of nothing more than a series of semi-circular barriers of grass about 2 feet in height, and 6 or 8 feet in diameter, arranged to face the prevailing wind. (Plate VII.)

A number of these wind-breaks are to be found at the principal camping grounds, and no more permanent shelter seems ever to be employed. The conditions on some of the other islands are said to be somewhat different in this respect. Numbers of stone fishtraps, similar to those at Sweer's Island, are to be seen round the coast of Bentink Island.

Dr. Roth, during a previous visit to the island, succeeded in obtaining a close view of a number of these natives, but during this opportunity no success was met with in this respect on any occasion of landing.

ABORIGINAL STONE FISH TRAPS, SWEER'S ISLAND

NUS

QUEENSLAND.

MAP I

To accompany report

WEST COAST OF THE CAPE
& SOME IS
OF TH
GULF OF CARPENTARIA
BY
C.F.V. JACI
ASSISTANT GOVERNM
1902

INDEX TO CO

D Desert Sandsto

T Shell Limestone
Calcareous Sand

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.

NATIVE CAMP, BENTINK ISLAND.

Bentink Island has a mean length in a north and south direction of about 9 miles, and an equal mean width.

The surface generally is rather more low-lying than that of Sweer's Island, a good deal of it being occupied by marshes and clay pans, the latter quite devoid of any kind of vegetation, and now covered by an accumulation of red dust, derived from the waste of the ridges.

The coast line is broken by numerous inlets or mangrove creeks, the head of some of which are seen near the centre of the island.

At the point chosen for landing, just to the south of Raft Point on the east side, is a prominent cliff of red ferruginous clayey sandstone, forming the eastern extremity of a low ridge which stretches across the island, and to the west and south the surface of the formation is quite flat, and at a much lower level scarcely above that of the sea, by which there is evidence of it having once been covered. A thin coating of loose yellowish clay now covers the surface, which is reddened by the ferruginous dust or gravel, and slightly hardened by a salty crust, which produces the appearance of a large clay pan or salt pan. This pan stretches towards the south, a low ridge of sandhills intervening between it and the shore. A number of such low-lying areas exists at different parts of the island.

About 3 miles from Raft Point higher beds of the formation again form a well-timbered grassy ridge several miles in width, and stretching across the island in a north and south direction.

The higher portions of this ridge are covered with spinifex grass, and the lithological characteristics of the rock are similar to the Desert Sandstone tablelands of Western Queensland, particularly in the development throughout its mass of large more or less spherical ironstone concretions or boulders, which are so common in the opal-bearing beds.

The country is generally well-grassed where these higher sandstone beds are found, and they also form prominent cliffs in several places along the west coast.

A small area of the calcareous sandstone similar to that described as forming Point Inspection on Sweer's Island is found on the south end of Bentink.

With the exception of these small areas of calcareous rock or shell limestone, the whole of these islands, as well as Fowler Island close to the south-east end of Bentink, and connected to it by a reef of rocks, are composed of rocks which are, no doubt, portions of the Desert Sandstone formation (Upper Cretaceous), and may be mapped accordingly.

It is a matter of great regret that the time available did not permit of a visit being made to the other islands—Mornington, the largest of the group, and Bountiful, about 30 miles north. From descriptions however, especially those of Captain Lort Stokes, and observations in the more southerly situated of the islands, I have no doubt that the geological formation of these two islands is identical with the others of the group, and that there is sufficient justification for thus provisionally mapping them.

There are other important groups of islands in the Gulf lying beyond the boundary of Queensland, and it may be mentioned that on one or two of the smaller islands to the west of the Wellesley group deposits of guano have been found,—more particularly Lake's Island, a small island not marked on the charts, from which on one or two occasions valuable cargoes were obtained. (Lat. 16-14 S., Long. 139-30 E.)

On returning across the Gulf tiresome delays by calms were experienced, Thursday Island not being reached until the 22nd July, and during a further enforced delay owing to their being no immediate steamer leaving for Brisbane, the opportunity was taken of visiting the Horn Island and Possession Island Gold Fields.

REPORT ON THE HORN ISLAND GOLD FIELD.

THE HORN ISLAND GOLD FIELD.

The discovery of gold on Horn Island was made by Messrs. Smyth and party in 1894, but for some years previously gold, though not found in payable quantities, had been known to occur on several of the other islands in Torres Straits adjacent to Thursday Island, notably Prince of Wales Island, where miners had, on and off, carried on a little desultory work.

These islands, the "Prince of Wales" Group, lie to the north-west of Cape York, the Endeavour Strait, which has a width of from 10 to 12 miles, separating them from the mainland. Gold has been found on Horn Island, Possession Island, Prince of Wales Island, Hammond Island, and Thursday Island.

The whole of Horn Island was proclaimed a goldfield in September, 1894, and since the date of this proclamation the returns have been as follows :—

	1894	320 oz. alluvial.
June, 1894, to June,	1895	569 oz. alluvial.
	1896	1,292 oz. from 1,311 tons
	1897	110 oz. alluvial. 741 oz. from 1,180 tons.
	1898	2,559 oz. from 3,794 tons.
	1899	329 oz. from 533 tons.
	1900	759 oz. from 9,819 tons.
	1901	Nil.

Before the efforts were made to develop the field on a large scale, during the latter half of 1899 and 1900, operations were carried on by prospectors and small syndicates, and the reef material was treated in a small 5-head battery and berdan pans.

In a report by Mr. Rands in 1896 (No. 112 of the Geological Survey Publications), the Horn Island workings are thus described :—

"The area of the field, on which mining was being carried on, is comparatively small; a rectangle of 50 chains in length by half-a-mile in breadth would include all the present workings. Rocks of the same character as those met with here extend over a large portion of the island, and it is therefore highly probable that auriferous reefs will be found not to be confined solely to this small area.

"The field is situated on ridgy, but not very rough, country to the south of Spring Creek.

"The country is composed of granite, consisting of felspar and quartz, and often containing a light green and soft mineral, a product of decomposition. The felspar occurs in large porphyritic crystals, and is of a flesh colour. This rock occurs over a large portion of the north-eastern part of the island, but I had no opportunity of visiting the southern or western portions.

"Along Spring Creek there is a fringe of recent alluvial deposits, which has not been tried for alluvial gold, nor is it probable that payable gold would be found, as it would be too much distributed over a flat which averages 12 chains in width. Two or three gullies running into Spring Creek and Smyth's Creek have been worked for alluvial gold; in fact, these were the only workings for several months after the discovery of the field. I found it very difficult to ascertain, even approximately, what amount of alluvial had been won, but I understand that over 500 oz. were obtained from the gully in Smyth's Reconstruction Claim.

GEOLOGICAL SURVEY OF QUEENSLAND

MAP No 4

REPRINT OF MAP PREPARED BY W.H.RANDS 1896

To accompany report on a visit to the

WEST COAST OF THE CAPE YORK PENINSULA & SOME ISLANDS OF THE GULF OF CARPENTARIA & TORRES STRAIT

BY

C.F.V. JACKSON

ASSISTANT GOVERNMENT GEOLOGIST

1902

SCALE 6 Chains to an Inch

3 0 6 12 18

Drawn by A McLaren at the Geological Survey Office Brisbane.

INDEX OF COLORS AND SIGNS

- Recent Alluvial Deposits
- Granite (G)
- Quartzites (Age undetermined) (Q)
- Felsite Dyke
- Reefs (Arrow denotes direction of Dip)
- Contour Lines (Approximate)
- Vertical Shafts
- Underlie Shafts
- Open Cuttings and Trenches
- Vertical depths of Shafts in feet (23')
- Heights above Sea-Level in feet (303)
- Boundaries of Claims (Approximate)

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.

"The reefs are all nearly parallel, having a bearing from west-north-west and east-south-east to north-west and south-east (*see* Map No. 4). The general dip of the reefs is to the south-south-west at a very steep angle, while some are nearly perpendicular. The reefs vary in width, as will be seen in my detailed account of the different claims, from an inch or two up to 3 or 4 feet. The "formation rock" is, in nearly every case, a somewhat decomposed granite.

"One of the chief peculiarities of the reefs on this field is the shallow depth at which the sulphides (mundic stone) occur—in most of the reefs at a depth of not more than 10 feet from the surface. The mundic consists chiefly of iron pyrities and galena. Some of the reefs contain zincblende, and in two instances copper pyrites occurs in small quantity. Some doubt has been expressed as to whether the stone can be treated by the ordinary crushing and amalgamating machinery, but, unless the quantity of galena in the quartz increases, I think with good grinding-pans that it can be successfully treated.

"The gold occurs in the reefs in a finely divided state, though in some of the quartz coarse gold is visible. The yield of the stone has, up to the end of April of the present year, averaged 1 oz. 2 dwt. of gold per ton; 981 tons having yielded 1,081 oz. 12 dwt. of gold. The value of the gold varies from about £2 10s. to £3 0s. 9d. per ounce. This return is a fairly good one, but at the same time it should be pointed out, as will be seen in the Appendix* to this report, that it is made up of a number of very small crushings. Altogether there are crushings from 27 claims, and in only two instances have the amounts of stone crushed reached 100 tons.

* APPENDIX.

List of Crushings from Horn Island Gold Field up to 30th April, 1896.

Name of Claim.	Quantity of Stone.	Yield of Gold.	Value per Ounce.	Where Treated.
	Tons cwt. qr.	Oz. dwt. gr.	£ s. d.	
Digger's Luck	1 2 0	7 9 0	2 13 0	Aldershot
Ditto	29 5 0	62 11 0	2 11 2	ditto
Ditto	12 0 0	14 15 0	...	Local Battery
Pioneer (Nos. 1 and 2 Reefs) ...	8 6 0	39 12 18	2 15 1	Aldershot
Ditto	2 8 0	29 1 6	3 17 10½	Sutton, Brisbane
Smyth's Tailings	30 0 0	4 5 0	3 0 3	Local Battery
Eclipse	30 0 0	111 18 13	2 15 0	ditto
Ditto	21 0 0	79 10 0	...	ditto
Good Luck	63 0 0	66 2 0	2 16 1	ditto
Ditto	76 0 0	45 9 0	...	ditto
Bonanza	15 0 0	39 16 0	...	ditto
Carroll's Surface	15 0 0	4 14 0	...	ditto
Triumph	100 0 0	123 8 0	3 0 3	ditto
Welcome	10 0 0	10 0 0	...	ditto
Ditto	30 0 0	38 15 0	...	ditto
Narupai	54 0 0	68 4 0	...	ditto
Gympie	59 0 0	72 12 12	...	ditto
Band of Hope	15 0 0	2 15 0	...	ditto
Rosetta	60 0 0	35 16 0	...	ditto
Dead Cat...	51 0 0	54 11 0	...	ditto
Mystery	20 0 0	4 6 0	...	ditto
Golden Gate	22 0 0	19 4 0	...	ditto
Cornucopia	27 0 0	52 3 0	...	ditto
Ornithorhynchus	22 0 0	18 13 0	...	ditto
Brilliant	94 0 0	17 0 0	...	ditto
Brilliant No. 1 West	11 0 0	6 1 0	...	ditto
Crossley's Tailings	10 0 0	4 14 0	...	ditto
Horn Island	10 0 0	7 0 0	..	ditto
Ditto	46 0 0	19 8 0	...	ditto
Tremayne's	8 0 0	2 2 0	...	ditto
Norseman	8 0 0	2 6 0	...	ditto
New Chum Venture	8 0 0	4 4 0	...	ditto
Eureka	9 0 0	6 14 0	...	ditto
Try Again	4 0 0	6 12 0	...	ditto
	981 1 0	1,081 12 1		

The various reefs and claims on the field are then described, the largest being the Mystery or Dead Cat Reef; and a detailed account of all of these will be found in the Report.*

Most of the islands of the Prince of Wales Group are very hilly, the hills in many cases rising up abruptly from the seashore to heights of from 300 to 700 feet; and, in fact, all these islands which stretch across Torres Straits to the north may be regarded as a submarine prolongation of the great mountain chain of the East coast of Australia.

The northern portion of Horn Island is somewhat flat and sandy, with boulders of porphyritic granite projecting here and there, and lofty isolated hills, composed of the same rock, rise up in places out of the flat. On the eastern side of the island, hills rise up to a considerable height almost directly from the seashore, the Horned Peak (Dingubai), from which the island has been named, being 376 feet in height, and composed of white quartzite. This rock occupies the eastern margin of the island, and stretches from King Point nearly to Papou Point, and on the west of it is the porphyritic granite. (*See* Map No. 3.)

The auriferous reefs are all in the granite near its eastern edge, and the workings are situated just to the south of the Horned Peak.

On reference to the table (page 16), showing the annual output of the field, it will be seen that, except for a rather large crushing in 1898, there was no very large increase until 1899-1900, when 9,819 tons of stone was put through for a return of 759 oz., and in the following year the output is given as nil. This, no doubt, represents the operations of a company which procured Smyth and party's interest and erected a large and costly crushing plant, but after working for a short time ceased operations.

The company obtained leases which apparently included the auriferous reefs referred to in Mr. Rands' report, as the Band of Hope and the Welcome, but beyond the work carried out by them, and a few shallow shafts and surface workings, there is very little change in the state of the field since 1896.

Mr. Rands thus describes the Band of Hope and Welcome Claims:—

"The Band of Hope Claim.—What is called the Band of Hope Reef is a seomwhat decomposed granite dyke. The rock was a very fine-grained felspathic granite, quite distinct from that of the surrounding country. The dyke stands out prominently, forming the summit of a ridge, and running in a nearly east and west direction. Through this dyke small veinlets, or threads, of quartz are running. The open workings are from 6 feet to 8 feet in width, and about 8 feet to 10 feet in depth, and after seven months' work there was not more than 200 tons in the paddock. I tried a great number of prospects, in most of which only a few small colours were visible, and the gold seemed to be very light. Now and again, I was informed, much better prospects could be obtained.

"The crushing was started while I was on the field, but it was soon stopped, as the plates were looking so badly. On washing up, 15 tons of stone had yielded 2 oz. 15 dwt. of gold, or 3 dwt. 10 gr. of gold per ton.

"The Welcome Claim.—The Welcome Reef is about 7 chains slightly south of east of the Rosetta. The shaft was down only 12 feet on a vertical reef bearing west 40 degrees north. The reef was lost at the bottom of the shaft. The claim was under exemption. Forty tons of stone yielded 49 oz. of gold equal to 1 oz. 4 dwt. 1 gr. of gold per ton.

"A good deal of surfacing had been done round about the shaft. I understand that it was good, although I could not get any actual particulars."

The auriferous reefs, which, at a small depth, became very refractory are in the porphyritic granite, and there are a number of small leaders and thin veins or off-shoots, also auriferous, which strike in different direction through the mass.

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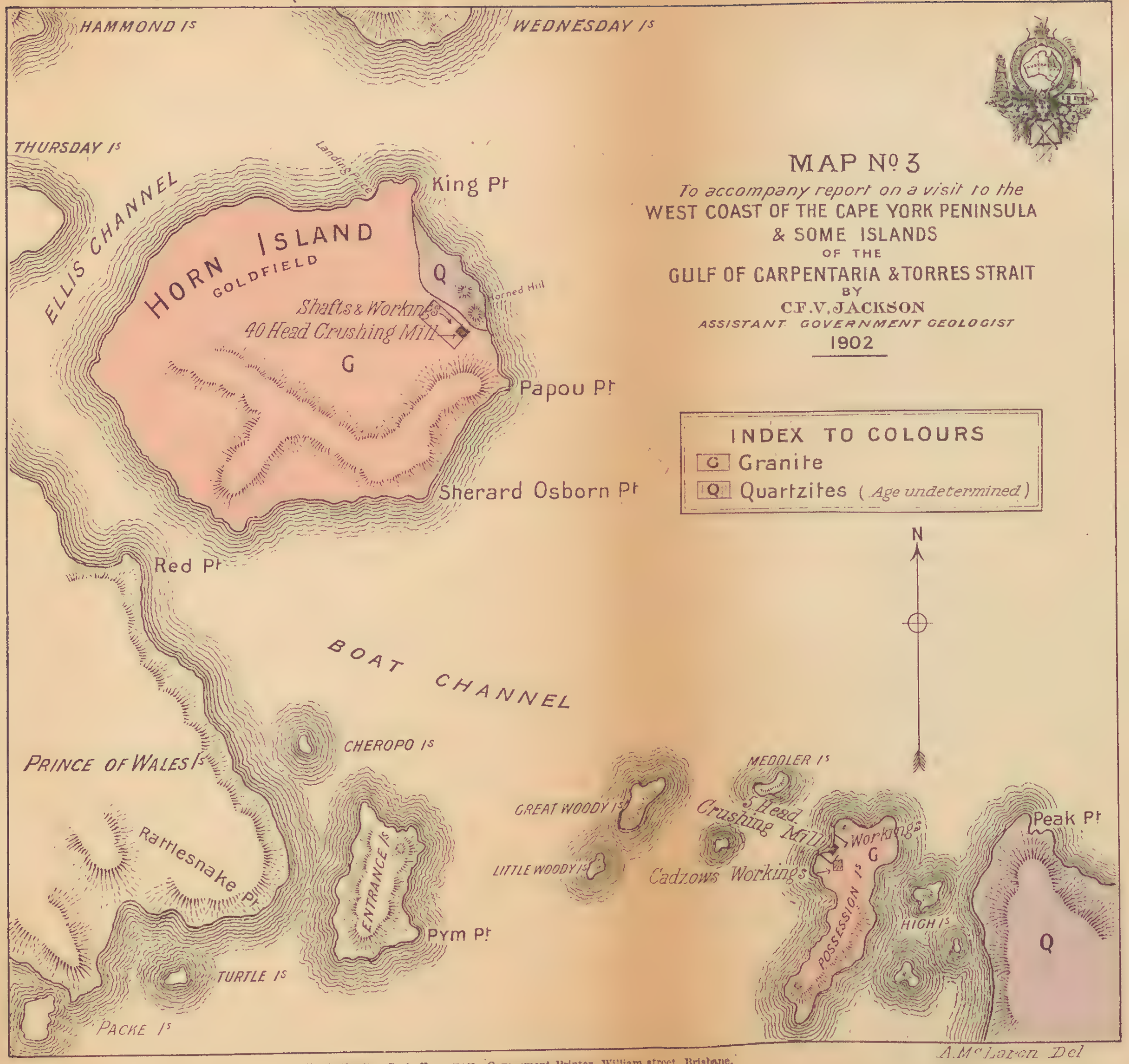
* No. 112 of the Geological Survey Publications.

GEOLOGICAL SURVEY OF QUEENSLAND.



MAP No 3

To accompany report on a visit to the

WEST COAST OF THE CAPE YORK PENINSULA
& SOME ISLANDS
OF THE
GULF OF CARPENTARIA & TORRES STRAIT

BY
C.F.V. JACKSON
ASSISTANT GOVERNMENT GEOLOGIST

1902

INDEX TO COLOURS

G Granite

Q Quartzites (*Age undetermined*)

A. McLaren Del

By Authority: G. A. VAUGHAN, Government Printer, William street, Brisbane.

CRUSHING MILL ERECTED AT HORN ISLAND SHORTLY BEFORE OPERATIONS CEASED.

With the denudation of the country and the oxidisation of the sulphides, these reefs and veins shed their gold, and good colours or prospects could be obtained almost anywhere the surface material was tried.

Good alluvial gold, also derived from these outcrops, was obtained in the creeks and watercourses.

Encouraged by such prospects a company was formed with a large capital and elaborate machinery was put up, the intention apparently being to treat the country in the vicinity of the reefs *en masse*.

The plant, which has scarcely been used, consists of a crushing mill of forty stamps, fitted with concentrating tables of the percussion class, Berdan pans, and the most modern type of boilers and engine, also an electric lighting plant, assay laboratories, drays, tools, steel trucks, &c., all of which are now lying idle. (Plate VIII.)

The water supply was obtained from the sea, for which pumps were provided and driven by rope gearing from the main shaft.

The actual mining operations of the company seem to have been confined to making a large open cut from 3 to 4 chains in length by about 2 chains in width from which the material for treatment at the mill was obtained.

This is about 30 feet deep, and along the bottom on the west side a reef, probably the Welcome Reef, can be traced from end to end of the cutting.

On this reef two shallow shafts had been sunk, but they were full of water and could not be examined.

The material which was being treated in the mill, and some of which is now to be seen in the ore bins and feeders, consisted in great part of country rock. Running through some of the pieces were small veins ranging to three-quarters of an inch in thickness; but a heap of ore on the crusher floor was made up of more than 90 per cent. of country rock. The small veins, however, which were filled with quartz and a large percentage of sulphides, contained a good deal of gold, and an assay of an approximate sample of these, exclusive of the country rock, gave—

Gold	22 oz. 2 dwt. 5 gr.
Silver	11 oz.

The rich ore obtained by Smyth and party about 1896 or 1897 was found at a shallow depth in what is now the open cutting.

The reef, which can be traced along the floor of this cutting on the west side, has a strike of about 125 degrees, and is almost vertical, the slight inclination being towards the south and west.

Its thickness varies from $\frac{1}{2}$-inch to 3 or 4 inches, though in one or two places it is nearly 6 inches thick. It is sometimes divided by a portion of the country rock, and there are numerous small veins or leaders branching from it.

The country rock on either side consists of a porphyritic granite containing large crystals of quartz and felspar, and a quantity of the green products of decomposition of its ferro-magnesian constituents.

Where seen exposed in the bottom of the open cut even at the shallow depth of 30 feet, the ore vein is filled largely with mineral sulphides and a quartz gangue, the minerals being chiefly galena, mispickel, and iron and copper pyrites, the latter in small amounts; a little zincblende is also present.

Most of the gold found on the surface before the open cut was made was derived from this reef and adjacent small veins and leaders. A sample taken from the vein, where exposed in the cutting, yielded on assay—

Gold	1 oz. 5 dwt.
Silver	2 oz. 0 dwt. 10 gr.

But probably most of the gold was in a non-amalgamable form, as the sulphurets which form roughly about 70 or 80 per cent. of the ore cannot in general be made to yield 40 per cent. of their gold as amalgam.

Whether an adequate trial of this reef was made by the company it is difficult to say merely on an inspection of the abandoned workings, as the shafts are now full of water and cannot be examined; but they were apparently not very deep, and I am inclined to think that the search may not have been exhaustive.

Certainly the amount of preliminary prospecting work would not, except under most exceptional conditions, warrant so large an outlay on plant, and the scheme appears to have been another of those regrettable instances, in which, had reliable technical advice been followed, the funds would not have been exhausted in providing costly and elaborate treatment appliances; before any adequate trial could have been made of the quality and quantity of ore available.

Without an examination of the shafts which, as already mentioned, were never very deep, it is also difficult to estimate the value of the company's operations after the erection of their plant, but the disappointment met with at the outset, as well as the reluctance to sink further money, probably led to the immediate cessation of operations.

As a sample yielded 1¼ oz. gold to the ton, and other veins exist in close proximity, which might reasonably be expected to be equally auriferous, there would seem to be enough of inducement to justify more systematic prospecting by shafts and crosscuts, when a sufficient quantity of ore might be found to pay for mining, and more appropriate treatment with machinery adapted to the purpose.

There has been a good deal of irregular alluvial work since Mr. Rands' visit in 1896, and there are a number of additional shafts and surface works on the different reefs which are all approximately parallel.

None of the shafts appear to have been sunk beyond the ordinary depth attainable with a hand windlass, and they have all been abandoned and are full of water. Another of the numerous parallel veins, however, was exposed in an open cutting, about a quarter of a mile to the west-north-west of the company's workings, and a sample from here assayed—

Gold	1 oz. 0 dwt.
Silver	1 oz. 19 dwt.

The ore is of precisely the same character as that previously described, and the thickness of the veins varies from ½-inch to 4 or 5 inches. The thicker portions contained more quartz and gangue, but the country rock on either side was more or less impregnated with mineral.

The Horn Island field, as far as mining operations are concerned, is now practically deserted, only some four or five Chinamen working with cradles on the surface material from the outcrops of several of the reefs.

The company are endeavouring to negotiate for the sale of their plant, which is in charge of a caretaker, and which, if remaining for very long without being kept in repair, will quickly deteriorate, owing to the action of the strong sea air on the castings.

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SHAFT AND WORKINGS ON BEACH, POSSESSION ISLAND.

REPORT ON THE POSSESSION ISLAND GOLD FIELD.

GOLD-MINING AT POSSESSION ISLAND.

Possession Island is about 10 miles south-south-east of Horn Island, close to the mainland (Peak Point, the north-west corner of the Peninsula).

The development of this field of mining operations is entirely due to the enterprise of Mr. Embley, surveyor, who first interested himself in prospecting there about the year 1896. A small treatment plant has been erected and a good deal of mining carried on, the following being the returns to date:—

	Tons.	Oz.
1897	780 ...	450
1898	1,185 ...	586
1899	492 ...	432
1900	363 ...	751
1901	545 ...	261

The general features of this island are somewhat similar to those of Horn Island, but the area considerably less; it is about 3 miles in length, by a little over 1 mile in breadth, and composed largely of a porphyritic granite similar to that of Horn Island. Its longest axis lies in a north-east and south-west direction, and the workings are situated on the north-west side.

Unfortunately, at the time of my visit the prospectors were away from the island, so that I was not able to obtain any information beyond what could be actually seen.

There are workings on several lines of reef, and there are no doubt others which have not been prospected, as the outcrops can be seen where the rocks are washed clean along the shore.

The chief workings are centred about two lines of reef, which have a south-south-east strike and are almost vertical; they are approximately parallel, and from 10 to 12 chains apart.

On the more easterly some extensive work has been carried on.

The workings on this reef are situated on the shore just at about high-water mark, but it was not possible to examine the shaft, which was flooded; and the presence of water in this shaft must have caused considerable trouble. It was well-timbered, and apparently had been sunk to a considerable depth, being worked by means of a horse and whip. (Plate IX.)

The reef consists of a number of quartz veins running through a somewhat decomposed porphyritic granite, and the outcrop can be traced on the sea shore just below the workings. The small veins ramify through the rock, being generally about vertical, and varying in thickness from a film up to 1 or 2 inches. They form a group several feet in width, and are filled chiefly with quartz and a small proportion of mineral sulphides.

Owing to the water it was not possible to obtain samples from the shaft, but some ore lying at the surface looked of very poor quality. I was informed that the reef had been driven along on the seaward side for some distance at the bottom of the shaft, which I believe has not been worked for some eight or twelve months.

About 60 yards south of this shaft another shaft has been sunk on the reef which was worked at a more recent date; it was also full of water, being worked with a hand windlass, and was, I should judge, about 60 feet deep.

Between the two shafts the reef has been opened up along the outcrop. A heap of ore, apparently set aside for treatment, was lying at the top of this shaft, and was of the same character as that previously described, *i.e.*, small quartz veins in a decomposed porphyritic granite; the veins also contained galena and iron pyrites, and varied up to 2½ inches in thickness.

A sample from these veins yielded—

Gold	1 oz. 17 dwt. 5 gr.
Silver	1 oz. 1 dwt. 19 gr.

But this, of course, was a sample of the veins only, and does not represent the value of the whole material regarded as an ore.

Another shallow shaft 20 feet in depth was sunk a little further south, but was apparently off the line of reef.

Some 10 to 12 chains further west there is another reef of considerable size on which a good deal of work has been done, and this reef has approximately the same strike as the previous one but dips to the west. The outcrop can also be seen on the sea shore from which the cliffs rise abruptly to about 110 feet in height. A tunnel was driven just above sea level and a good deal of work expended on this line of reef.

The character of the vein is somewhat similar to the other, *i.e.*, quartz veins in a rather decomposed porphyritic granite, some of the veins being several inches thick. The country rock is much more altered on each side by the influence of decomposing solutions, but there is no evidence of any movement, and no crushed and broken rock filling the fissures; the tunnel follows the vein for about 60 feet. For 30 or 40 feet on each side of this main fissure on which the tunnel has been driven, a number of approximately parallel small veins run through the country rock. A considerable amount of work has been done along the outcrop from the shore to the top of the cliff, which is 110 feet high, the country then sloping back to the east coast of the island.

At the summit of the hill an inclined shaft has been sunk to a considerable depth, the reef opened up, and ore removed from the surface to a depth of 50 feet; this stoping extending for 30 feet or more on each side of the shaft. (Plate X.)

The reef seems to be the same width here as at the sea level, but the shaft has not been worked for some time, and being full of water cannot be examined.

About 100 to 150 yards to the south, on the southern slope of the hill, an area of about 12 acres, in which I believe Mr. Embley is interested, has recently been taken up by E. T. Cadzow, and work is being carried on in the decomposed rock along the outcrop of an auriferous formation, probably a continuation of that previously described on which the tunnel at sea level has been driven.

There has not been very much work done so far beyond deep trenching along this outcrop, but I believe some very good gold has been obtained.

The plant on the island consists of a 5-head battery with two Berdan pans, salt water being used for treatment, and there is also a small cyanide plant; the latter, however, being apparently disregarded and in a state of disrepair. (Plate XI.)

OLD WORKINGS, SUMMIT OF CLIFF, POSSESSION ISLAND.

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BATTERY AND CYANIDE PLANT, POSSESSION ISLAND.

As far as can be judged, the actual amount of vein-stuff obtainable for treatment was not very large, and it seems probable that the ore being of low grade the tailings were not of sufficient value for economic cyanide treatment.

Though it is not possible to identify these veins with those being worked on Horn Island, it is noticeable that the general trend of the reefs of Possession Island is towards the north-west, and in one or two instances if the strike were constant the reefs would pass through the workings at Horn Island. No doubt the gold-bearing veins of the several islands in the vicinity are in the same auriferous zone.

A short time ago some very rich specimens, said to have been found on one of the islands of Torres Straits, were brought to Thursday Island by a Manilla man. Great secrecy was observed as to the locality, and a party of men were supposed to have set out in a small lugger to prospect the deposit.

The island was thought by some to be Banks Island (Moa), from 25 to 30 miles north of Thursday Island, but it is now more generally believed that the story was not genuine, and that the specimens were really obtained from Possession Island.

REPORT ON THE RECENT PROSPECTING OF THE CRETACEOUS COALS OF THE COOK DISTRICT.

Efforts have been made to discover coal in the Cook district since 1878, and the first mention of a seam of 8 inches and other outcrops at Oakey Creek and Deep Creek is to be found in a report by Mr. Jack (No. 3 of the Geological Survey Publications, 1879). These outcrops, and the coalfield of the Little River, one of the heads of the Kennedy, belong to an entirely different geological horizon to the other outcrops of the district, and the strata in which they occur have been mapped as belonging to the Bowen Formation (Permo-Carboniferous).

It may be mentioned that a report on the Little River Coal Field was prepared by Mr. Jack in 1882, but, though a number of seams varying in thickness from a few inches to several feet are mentioned, there is no opinion expressed therein as to the value of the deposit. A note of the occurrence of coal in the Desert Sandstone Formation (Upper Cretaceous) first appears in No. 4 of the Geological Survey Publications, 1879; a bed 4 feet in thickness of shale, the uppermost 8 inches of which was streaked with coal, having been found by Mr. Jack on the north shore of the Endeavour River. In 1891, Mr. A. Gibb Maitland reported on the geology of the Cook district and gave certain particulars regarding coal seams in the Desert Sandstone outcropping at Puckley's Creek and elsewhere.

A 10-inch seam of coal was cut by Messrs. John and Colin Christie in 1892 in their shaft, about 4 chains to the north of the $37\frac{3}{4}$-mile peg on the Cooktown Railway, at a depth of 121 feet, but this shaft was abandoned for reasons which will be explained hereafter. The seam at the $37\frac{3}{4}$-mile is in the Desert Sandstone, and this occurrence of coal and also a 10-inch seam outcropping at Stack's Creek, 6 miles south-east, was reported on by Mr. Jack in 1895 (publication of the Geological Survey No. 106). Embodied in this report was a recommendation, which was approved of by the Minister, that a diamond drill should be put down to test the strata below the outcropping seam, and with this assistance Messrs. Kortum, Fitzgerald, and others carried out the work during 1896. Prospecting operations ceased from that date until June of the present year when Messrs. Christie Brothers again set to work, and opened up a seam of coal outcropping half-a-mile to the north-west of the old shaft.

On crossing the divide between the Endeavour and Normanby, about 28 miles from Cooktown, the base of the Desert Sandstone rocks is seen from the railway line at an altitude of 400 feet above sea level, and this formation—save for a small area of granite which stretches from the 30-mile to the 36-mile, and has a width of about 6 miles—covers the whole of the Palæozoic rocks thence to the Laura terminus. West of this it extends as far as the range dividing the waters of the Palmer and Mitchell from those falling to the East coast. The greatest width of about 52 miles is at the western extremity, and the extent of country occupied by the formation may be roughly defined, with a general north and south boundary, as lying within a wedge-shaped area with the apex on the East coast just to the north of Cape Bedford 20 miles north of Cooktown. The width in the vicinity of the 38-mile is about 20 miles.

The southern boundary of this large area of Cretaceous rocks, in which the coals chiefly occur, is crossed by the railway between the Endeavour and Normanby River; and to the north and south of it, and in the vicinity of the

railway line to Cooktown, which follows the Endeavour Valley to its head, the country, except for the higher peaks which are capped by the more recent Desert Sandstone rocks, has been mapped as belonging to the Gympie Formation (Permo-Carboniferous). It consists chiefly of schists and slates, &c.

The thickness of the beds lying to the west of the Normanby River must have been at least 1,000 feet. From the summit of the highest peaks in the vicinity of the 38-mile, as far as the eye can reach, the sedimentary rocks appear to be disposed in a series of scarcely perceptible undulations, and the strata have a gentle dip of 4 or 5 degrees, generally towards the west and south-west. The following section, prepared from information contained in the report of Mr. A. Gibb Maitland, who mapped the district in 1891, illustrates the relation of the coal-bearing formation to the older Paleozoic rocks :—

Apart from the coal at Little River and Oakey Creek, outcropping seams of Cretaceous coals have been recorded at—

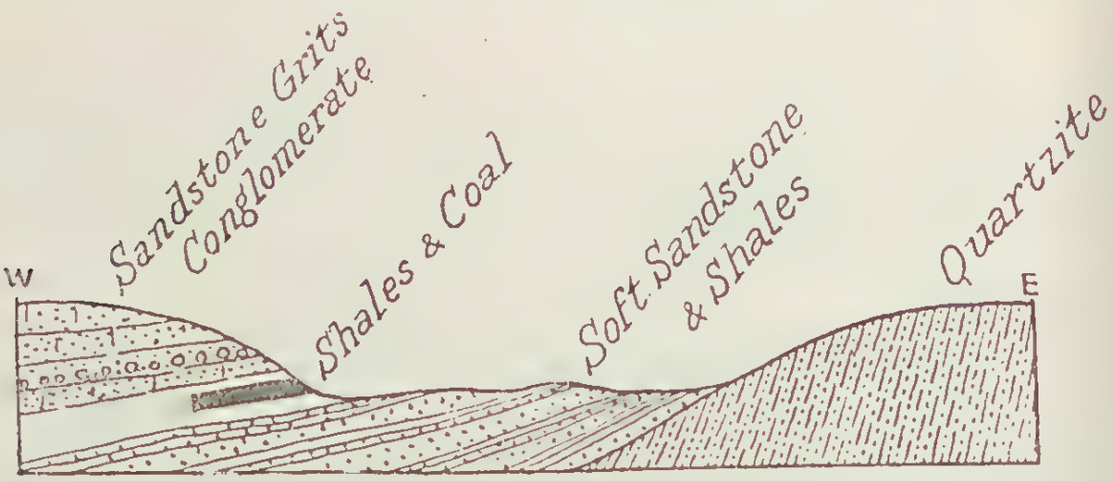
Guppy's Tableland between Cape Bedford and India Head	8-in. seam	
India Head	?	
Brannigban's Bluff	Thin seam	
Five miles up the Laura from the Railway Crossing	2-in.	,,
	5-in.	,,
Puckley's Creek	9-in.	,,
	4-in.	,,
Stack's Creek	10-in.	,,
37¾-mile peg, seam an old shaft	10-in.	,,
Half-mile N.W. of 37¾-mile peg (being opened up at present)	10½-in.	,,
	9-in.	,,

Prospecting operations have been confined to the three latter and largest. At Stack's Creek and the shaft at the 37¾-mile peg no work has been done for a number of years, but the stratigraphical information obtained there furnishes important evidence with regard to the existence of other coal seams. The outcrop half-a-mile north of the 37¾-mile peg is that being opened up at present by Messrs. Christie Brothers.

The existence of this outcrop exposed in a washaway on the western side of a gully near the head of one of the creeks, which probably runs into Welcome Creek, has been known for some years. East of this outcrop a massive quartzite forms the slope of the gully, the formation stretching for about three-quarters of a mile. An area of granite on the east of this occupies a further distance of about 6 miles. Above the outcrop on the west are a series of sandstones, grits, and conglomerates. The Messrs. Christie are driving a tunnel which follows approximately the dip of this seam, and they have now reached 150 feet. The strata exposed in the mouth of the tunnel are as follows :—

	Ft.	in.
Soft grey shales, about...	2	0
Grey Carbonaceous shale, about	1	9
Upper coal seam	0	10½
Band of gritty Carbonaceous shale	0	7½
Lower seam of coal	0	9
Under clay, about	1	0

A circumstance worthy of note is the presence of the clay beneath the seam, as Mr. Maitland, in 1891, drew attention to the entire absence of an under-clay or seat earth in the coals previously described at Puckley Creek and elsewhere. Beneath the shales and coal which dip to the south-west at an angle of 4½ degrees is a series of soft sandstones and shales.



SKETCH SECTION AT COAL OUTCROP, HALF-A-MILE NORTH-WEST OF THE 37¾-MILE, COOKTOWN RAILWAY.

A short distance from the mouth of the tunnel there is a slight decrease of the dip angle, and at 50 feet and 100 feet two small faults occur at about 45 degrees with a throw of about 6 inches, thence to the end of the drive the seam appears undisturbed. The first 100 feet of driving was accomplished by hand labour only, but the work is now being carried on with the assistance of a small pony. There has been removed and stacked at the mouth of the tunnel about 30 tons of coal, which it is the intention to send by rail to Cooktown and submit to a steam trial on the s.s. "Adelaide," a small vessel belonging to Messrs. Clunn and Sons, and trading to New Guinea. (Plate XII.)

As the question of the advisability of further prospecting this coal seam, or the whole of the strata, by means of diamond drill is a most important one, analyses have been made of both the upper and lower seams, with the following results :—

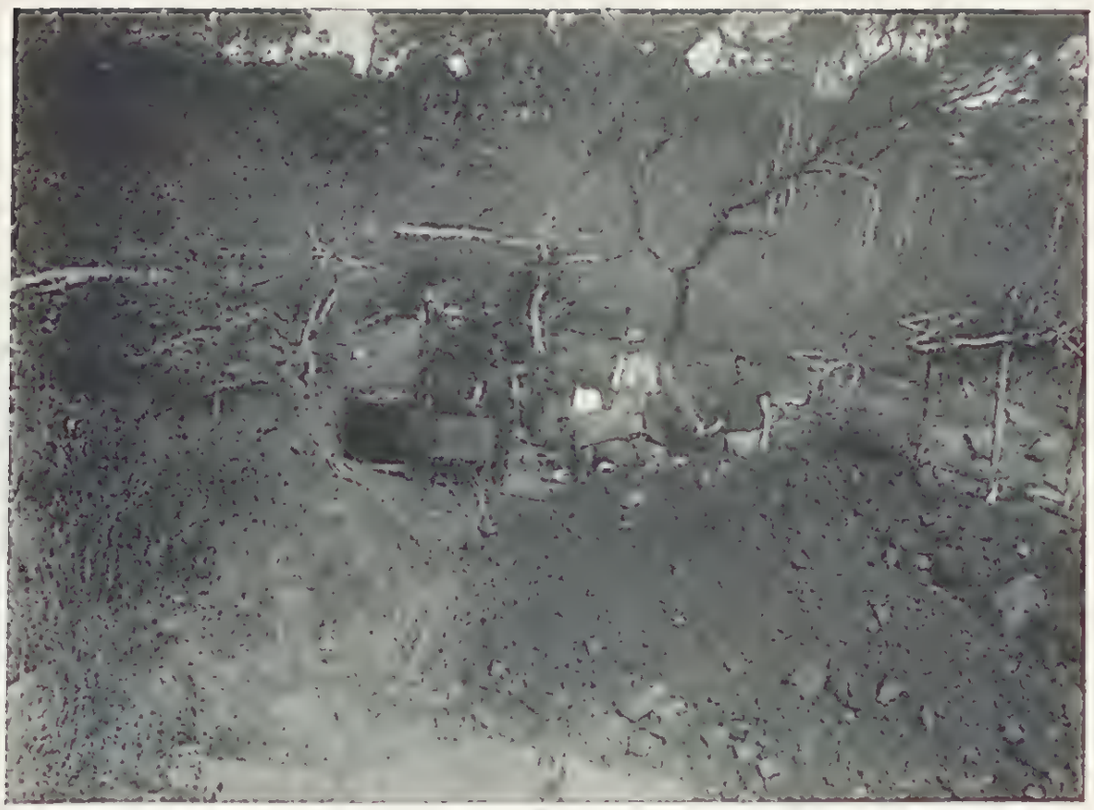
Description of Sample.	Moisture.	Volatile Hydro-carbon.	Fixed Carbon.	Ash.
Sample from upper seam	0·80	18·30	41·80	39·06
Sample from lower seam	1·645	17·89	33·95	46·51
Sample from coal waiting for shipment	1·025	20·185	42·45	36·34
Analysis from sample taken when drive had reached 50 feet	1·35	19·00	42·94	36·35

These results may be compared with the following :—

Newcastle, N.S.W., mean of 14 samples	2·25	35·25	56·51	5·00
Bulli, N.S.W., mean of 7 samples	1·09	20·84	67·23	10·25
Welsh coal, mean of 31 samples	...	21·15	74·70	4·15

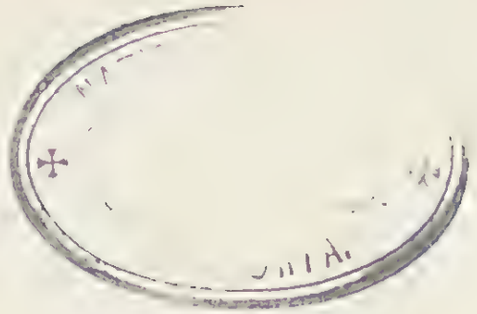
The upper seam gives rather the better result, but the coal from each when burnt is nearly half ash, and it will be seen that after the surface portion was removed there has been very little improvement in the coal, which is too poor in quality for economic use. Moreover, inadequate thickness is a condition restricting the availability of a coal seam, though just what thickness is inadequate is a relative and locally variable term. A bed uniformly thinner than 18 inches cannot ordinarily be considered available.

The shaley band separating the two seams of coal might be found on further prospecting to diminish, allowing a greater thickness of coal above or



TUNNEL ON COAL SEAM, 37¾-MILE, COOKTOWN RAILWAY.

CUTTING, MOUTH OF TUNNEL.



below, but I am of opinion that the conditions under which these coals were laid down were not favourable either for seams of great thickness or of very good quality, and it is doubtful whether any improvement would be permanent.

Evidence with regard to the possibility of finding other seams of coal at a greater depth is furnished by the old shaft at the 37¾-mile, and by the boring operations at Stack's Creek.

The old shaft sunk by the Messrs. Christie in 1892, close to the railway line at the 37¾-mile peg, is said to have been 246 feet deep, and from the bottom of the shaft a bore was put down a further distance of 99 feet, a total of 345 feet.

At about 113 feet a thin seam of inferior coal 3 inches thich was passed through, then 6 feet 9 inches of shales, and then a 10-inch seam of good coal.

An analysis of the latter published in a report by Mr. Jack in 1895 is as follows:—

Moisture	0·95
Volatile, Hydrocarbons, and Sulphur	19·77
Fixed Carbon	66·88
Ash	12·40

The strata above this seam consisted chiefly of sandstone streaked with coal, and below chiefly of sandstone and shales, which as far as the bottom of the bore contained no coal. When the bore reached 99 feet, however, or 345 feet below the surface, coal is said to have been touched—the fragments being washed up through the bore hole, but owing to the impossibility of keeping the water down in the shaft it had to be abandoned.

The strata at Stack's Creek, 6 miles to the south-east, were proved beneath the outcropping seam by means of a hand bore and the diamond drill recommended by Mr. Jack in 1895; a record of the beds passed through is not available. I am assured, however, by a member of the syndicate who put the bore down that no coal was met with, which being the case, it is somewhat difficult to reconcile the fact of coal having been found 230 feet below the first seam struck in Christie's old shaft, for, as far as can be judged without a more elaborate survey, there is every reason to believe that the Stack's Creek outcrop and that opened up at the 37¾-mile represent the same seam.

The lower seam in Christie's shaft, however, was never seen *in situ*, and thin, valueless seams or coal streaks which exist at different levels in the series may possibly have been passed through by the drill without their presence being recorded.

Mr. Jack, in recommending the drill, expressed the opinion that in all probability it would bottom on the granite or Palæozoic rocks, and settle once for all the existence of payable coal in the district.

The strata beneath the seam were proved by the drill to a depth of 600 feet, when the granite was met with; and though with the help of the additional stratigraphical information since obtained, the site for a bore would have been more advantageously chosen to test the Welcome Valley beds to the west of the 38-mile, there is not much doubt that even if the whole of the beds were not represented at Stack's Creek very little of the formation below the coal remains unproved.

Under present circumstances the question of finding a workable seam of coal in the Cook district is one of very general economic interest, and though prospecting enterprise in this direction is worthy of every possible encouragement the prospects do not appear sufficiently favourable to warrant any very large outlay.

[No. 180 of the Geological Survey Publications.]

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

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Queensland

DEPARTMENT OF MINES

GEOLOGICAL SURVEY REPORT No. 181.

ADDITIONS TO THE GEOLOGY OF THE MACKAY AND BOWEN DISTRICTS.

BY

WALTER E. CAMERON, B.A.,
ASSISTANT GOVERNMENT GEOLOGIST

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BRISBANE:
BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1903.

LETTER OF TRANSMITTAL.

Geological Survey Office,
Brisbane, 30th December, 1902.

Sir,—I have the honour to forward herewith a Report on "Additions to the Geology of the Mackay and Bowen Districts." The Report deals with a number of places in those districts visited during the months of June to September of this year. The greater part of June and July was spent in examining the coal beds north of the Pioneer River, and the remaining two months in visiting the other localities, Mount Flora, Mount Barker, Eungella, Normanby, and Byerwin.

One Map and one Plate are in preparation for this Report, which will be No. 181 of the Geological Survey Publications.

I have, &c.,
WALTER E. CAMERON,
Assistant Government Geologist.

To the Under Secretary for Mines, Brisbane.

ADDITIONS TO THE GEOLOGY OF THE MACKAY AND BOWEN DISTRICTS.

1.--COAL BEDS NORTH OF THE PIONEER RIVER.

Geology.

The geology of the Mackay district has been twice reported on by officers of the geological survey: by Mr. R. L. Jack* in 1887, and by Mr. Maitland† in 1889.

Mr. Jack, in his report, notes the occurrence of sandstones of considerable thickness on the road from Mackay to Bowen, between Constant Creek and St. Helen's Creek. He says of this sandstone that it "may be conjectured from the preponderance of siliceous sandy material to be the equivalent of the Lower Series of the Bowen River Coal Field." He also mentions the occurrence of coaly shales in portion 909, behind the Beaumont store, on Constant Creek, and of a fragment of water-worn coal said to have come from the neighbourhood of St. Helen's.

Mr. Maitland, in the map accompanying his report, shows the geological features of all the lower country east of the coast range, on both sides of the Pioneer River, from the Mount Funnel Range on the south to Black Rock Creek on the north. The geology of that portion lying north of the Pioneer River is further illustrated by two sections east and west across the country.

Mr. Maitland's map and sections show that the sandstones referred to by Mr. Jack lie with slightly undulating dip over a large area between the Pioneer River and Scrubby Creek. He also shows these to be underlain conformably by some thickness of bedded basalts and diorites, which are exposed round the edges of the sandstone hills. He refers both sandstones and underlying bedded volcanic rocks to the Bowen River beds of the Permo-Carboniferous system on account of their lithological resemblance to rocks of that age on the Bowen River.

About Scrubby Creek the sedimentary beds are disturbed by intrusive granite, but the sandstones are again found beyond the creek, on the left of the main road to Bowen, extending from the back of old St. Helen's Station to Black Rock Creek. The sandstones here dip to the south, and form a bold escarpment facing to the north. It was under these sandstone hills, in the bed of Black Rock Creek, that a seam of coal of apparently good quality was recently discovered, and this discovery, taken together with reports of other outcrops nearer Mackay, led to the hope that coal of good quality might be found in more accessible positions.

The immediate object of the writer's visit was first to inspect the outcrop on Black Rock Creek, and, subsequently, when there was no doubt of the coal being of good quality, to endeavour to trace the same horizon further south, where it would be more accessible from Mackay and the surrounding sugar mills. The accompanying map is the result of this attempt, and gives the writer's ideas of the geology of the country between the Pioneer and Black Rock Creek. The time devoted to the work was much too short to allow of an accurate and detailed geological map being made, and only the broad outlines are shown.

*The Geological Features of the Mackay district. R.L.J., Brisbane. By Authority, 1887.

†Geological Features and Mineral Resources of the Mackay district. A.G.M., Brisbane. By Authority, 1889.

Mr. Maitland classifies the rocks of the district into the following divisions, and describes their features in detail:—

Clastic Rocks	Alluvium Desert Sandstone (Cretaceous) Bowen River beds (Permo-Carboniferous)
Igneous Rocks	Desert Sandstone trachyte, lava, and ashes Bedded basalt, &c., of Bowen River Beds Intrusive diorites Granite Felsites Bedded diorites of undetermined age.

In the accompanying map the solid geology alone is shown except along the coast and main estuaries, where the alluvium has hidden all rock outcrops. The Desert Sandstone strata were not examined, and have been left as mapped by Mr. Maitland, while the mapping of the Bowen River beds has been altered to include not only the upper siliceous sandstones and the bedded basalt and diorites, but also certain underlying volcanic tuffs and conglomerates which occur along the coast, on the Seaforth Estate, and which apparently belong to the same series. These beds do not appear to have been noticed by Mr. Maitland, as the area they occupy is mapped as alluvium by him.

The siliceous sandstones and grits referred to by Mr. Jack, and mapped as Bowen River beds by Mr. Maitland, occupy a considerable area of the hilly country north of the river. As it was under these sandstones that the seam of coal on Black Rock Creek was discovered, some trouble was taken to accurately map their limits. The scale of the present map allowed of this being done in greater detail than is shown on Mr. Maitland's map. This was the more easily done, as, being considerably harder than the underlying strata, their occurrence in the field could generally be readily noticed.

Below the siliceous beds come more ferruginous and softer sandstones, shales, and coals, with frequent interbedded basalts and diorites. It is amongst the beds lying within the first 200 feet or so below the hard siliceous sandstones that the outcrops of coal have been met with. The igneous rocks bulk far more largely in these beds than the sandstones and shales amongst which they lie, so much so as to quite obscure the presence of the latter over large areas. The geology of these igneous rocks has been referred to by both Mr. Jack and Mr. Maitland. In his report (*ibid.*, page 2, line 3), Mr. Jack mentions the occurrence of a bed of diorite in a road cutting on portion 909, below the Beaumont store on Constant Creek. He says, "The surface of the diorite is vesicular, and the mass is therefore a bed and not intrusive." Mr. Maitland mentions numerous instances of the occurrence of shales and sandstones interbedded with sheets of basalt and diorite. He says, "That volcanic action went on during the period when the sedimentary strata were being formed in the Mackay district is shown by the presence of undoubtedly contemporaneous lava beds."

This volcanic action does not seem to have disturbed the overlying siliceous sandstone and grits, and presumably there was a cessation of volcanic energy during the time of their deposition. Unfortunately, however, for the prospect of finding large areas of workable coal among the underlying coal-bearing beds, this outpouring of volcanic rock during the time of their deposition seems to have destroyed the coal that may be presumed to have been in course of formation over considerable areas, leaving only traces here and there of their former existence, or in isolated cases restricted areas of undisturbed coal. Such an area no doubt is the one found at Black Rock Creek, and the endeavour of the writer was to try and form some idea of its extent, and, if possible, to

point out other areas more accessible to Mackay, and showing some prospect of containing workable coal. The results of this work were not as gratifying as could have been wished, but the question is dealt with in detail further on in the report.

Below the horizon of coal-bearing shales and sandstones and their interbedded volcanic rocks, there occur along the coast, from Cape Hillsborough to the mouth of Black Rock Creek, a series of volcanic tuffs and conglomerates, which have not been mapped by Mr. Maitland, but which are apparently the equivalents of similar strata noticed by him in the neighbourhood of Mount Toby on the western side of the siliceous sandstone area. They are apparently comformable with the overlying coal-bearing strata, and, if so, form the lowest members of the Permo-Carboniferous Series found in the district. No doubt they represent the initial stages of the volcanic action of which the basalt flows of the overlying beds were the subsequent result. Very probably they are the equivalents of similar fragmental volcanic rocks described by Mr. Jack as occurring below the lowest division of the Bowen River beds in the Bowen River Coal Field,* and of those described by Mr. Dunstan as occurring interbedded with his lowest division of the same rocks along the Dawson Valley. If so they must be very nearly at the base of the Bowen River Formation, though their lowest members are not exposed. Interbedded with these volcanic rocks among their upper members are even-bedded fine-grained flagstones and shales, which, from the regularity of their bedding, were apparently laid down in comparatively deep water, and give every appearance of being of marine origin.

As yet there is no palæontological evidence by means of which the age of the beds classed here as Permo-Carboniferous, can be definitely determined. The opinion of both Mr. Jack and Mr. Maitland, as to their stratigraphical and lithological resemblance to beds of Permo-Carboniferous age on the Bowen River Coal Field, must suffice to leave them for the present in the Bowen River Formation. Mr. Maitland remarks that "the tripartite division of Mr. Jack of this formation on the Bowen River Coal Field cannot here be made out." Mr. Dunstan in his report on the Coal Measures of the Dawson and Mackenzie,† discusses Mr. Jack's classification of the Bowen Beds in detail, and, according to his idea, they should be divided as follows:—

Upper Bowen Formation { Old alluvial deposits of Clermont
Freshwater Series
Marine Series.

Unconformity:

Lower Bowen Formation { Upper Freshwater Series
" Marine Series
Lower Freshwater Series
" Marine and Volcanic Series.

Notwithstanding the absence of palæontological evidence, it may be surmised that the volcanic tuffs and conglomerates, and fine even-bedded sandstones of the coast north of Cape Hillsborough, are the equivalents of the "Lower Marine and Volcanic Series" of Mr. Dunstan, while the sandstones, shales, and coals with their interbedded basalts as well as the overlying siliceous grits correspond to his "Lower Freshwater Series," the boundary line between the two formations being obscured by the contemporaneous outpouring of basic igneous lavas.

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* Report on the Bowen River Coal Field. R.L.J., Brisbane. By Authority, 1879, page 4.

† Geology of the Dawson and Mackenzie Rivers. B.D., Brisbane. By Authority, 1901, page 21.

The Outcrop of Coal on Black Rock Creek.

The outcrop of coal on Black Rock Creek is on portion 1450. Two pits have been sunk in the shingly bank of the creek and expose beds of coal and shale, but the work has not been done with sufficient skill to enable one to satisfactorily judge of the thickness of the seams. In the pit further down the creek, the length of which runs diagonally across the strike of the beds, about 4 feet of good coal are seen, and in the other pit, which is some five paces further up, another 3 feet or so. To expose the coal properly these two pits should be joined by a trench going as nearly as possible directly across the strike of the beds. The coal strikes about east and west and dips at an angle of about 45 degrees to the south. There seems little doubt that there is here a considerable thickness of workable coal of good quality. An analysis of a sample of the coal from both pits, made at the Government Analyst's Office, gave the following result:—

Analysis of Black Rock Creek Coal.

Moisture	0·95 per cent.
Volatile hydrocarbon	23·54 „ „
Fixed carbon	59·40 „ „
Ash	16·11 „ „

The coal is black and lustrous, breaking with a good cubical fracture. The percentage of ash is high, but as the sample was taken right from the outcrop, this may be expected to decrease considerably as the outcrop is left behind. The expenditure of a few pounds in opening up the seam and testing a sample in bulk would soon settle the question of the adaptability of the coal for high steaming purposes. From its analysis it should be an excellent coal for general steaming and domestic purposes.

A few yards up the creek from the outcrop, two smaller pits again expose coal seams, though of inferior quality. Apparently these are the seams mentioned by Mr. Maitland in his report (*ibid.*, p. 11). The first pit shows a dyke of diorite in contact with the coal, which it has charred considerably. Whether this diorite also affects the underlying seam it is impossible to say, but its occurrence is an indication that here also the coal beds have been interfered with by volcanic rocks, which may have destroyed the coal over considerable areas. Further up the creek the siliceous sandstones overlying the coal-bearing beds are found dipping at very high angles in the same direction as the coal. Mr. Maitland in his report (*ibid.*, page 222) considers that the sandstones here have been faulted against the coal bed. I am inclined to the opinion, however, that when followed to the dip, the latter will be found to dip in conformity with the overlying sandstones.

The sandstones can be traced to the south as a regular line of hills for about 3 miles with gradually flattening dip till near St. Helen's Station, where the dip is only about 30 degrees. The talus from the sandstone hills obscures the underlying coal beds for some distance back from the hills. A bed of ironstone however, about half-a-mile back, can be traced with great regularity and with a strike conforming with that of the overlying sandstones for about 2 miles from Black Rock Creek, and seems to show that the coal beds are not appreciably disturbed for that distance. There are, therefore, good prospects that there is south of Black Rock Creek a considerable area of little disturbed coal-bearing country, in which at least one seam of good workable quality may be confidently looked for, and which may contain others not yet discovered.

The approximate positions of the outcrops of sandstone and ironstone are shown on the map. This area seems to afford the best possibilities of carrying good coal of any area in the district. The coal outcrop on Black Rock Creek might be traced to the south under the sandstone hills by shallow boring, and the seam opened out over a considerable length of outcrop by shallow pits, before systematic development is undertaken.

Presuming, however, that there is in this neighbourhood sufficient coal to warrant the commencement of mining operations on a large scale, there comes the question of the possibility of getting the coal to a market. Black Rock Creek is 40 miles from Mackay, where the shipping facilities are very poor. It is about 18 miles from Port Newry, the shipping facilities of which are often referred to. Before any conclusion, however, can be come to as to the adaptability of this port for shipping large quantities of coal, an estimate of the cost of rendering it available for such work would have to be obtained from a competent engineer.

The coal beds of Black Rock Creek are cut off in a north-westerly direction by the granite of Mount Catherine, which has here intruded them. Further north-west again, however, there are many possibilities of occurrences of coal, but as we are getting further from a port in this direction, the question of the occurrence of coal in this locality can well wait till the beds nearer Mackay have been shown to be workble at a profit.

The Prospects of Coal between Scrubby Creek and the Pioneer.

Between Scrubby Creek and the Pioneer the outcrop of the coal-bearing horizon can be pretty accurately defined by the limit of the overlying siliceous sandstones. Unfortunately, however, for the prospect of obtaining good payable seams nearer Mackay, contemporaneous volcanic action seems to have been on such a scale as to have considerably interfered with the coal beds, and it is difficult to point out places which give much hope of repaying prospecting. Besides this contemporaneous volcanic action, the beds have since been further intruded by granite and felsite rocks, of which Mount Jukes and Mount Blackwood are the most prominent outcrops. Near the Beaumont store, on Constant Creek, portion 909, parish of Hampden, an outcrop of coal had been met with in sinking a well, and a shaft sunk to a depth of some 67 feet to prospect the coal. Mr. Dunstan inspected this shaft in 1901, and refers to it thus :—*

The first seam was penetrated at 16 feet, and contains 2 feet of an inferior anthracite, the analysis of which is as follows :—

Analysis of Hampden Inferior Anthracite.

Moisture	2·4 per cent.
Volatile hydrocarbon	2·2 ,,
Fixed carbon	65·8 ,,
Ash	29·6 ,,

Mr. Dunstan then gives a sketch showing a section of the strata penetrated in the shaft, with three distinct coal seams, all of which are anthracite but of inferior quality. The first seam is 2 feet in thickness, at a depth of about 16 feet, the second 1 foot 6 inches at 45 feet, and the third 5 feet at a depth of 60 feet.

I was shown some of the rock since met with at the bottom of the shaft below the coal. This is a white felsite similar in character to the rock of which Mount Blackwood is composed. A bar of this rock also crops out between the shaft and the main road, and on the road itself, and the coal-bearing beds on this portion form a small detached area, broken away from the main mass by the intrusive felsite rocks referred to above. The near presence of these masses of igneous rocks probably accounts for the anthracitic character of the coal. These coals must be on nearly the same horizon as those at Black Rock Creek, if, indeed, they are not identical seams, for the overlying siliceous sandstones are found a few hundred yards further up the creek. They have, however, been so disturbed by the intrusive rocks of the adjoining hills that

* Geological Survey Bulletin, No. 17, page 12.

there seems little prospect of a good workable seam being found in the immediate neighbourhood. Further down the creek, however, between it and the road, on portions 782, 1177, 152, 1031, 749, and 566, there seems to be more prospect of getting away from the disturbing influence of both the granitic intrusions and the basalt outflows. The strata here are practically horizontal, the siliceous sandstones occupying the higher ridges, while the soft coal-bearing measures are seen in the lower ground of the creek beds. These coal-bearing beds would have to be prospected by boring, and in order to avoid boring through the hard siliceous beds capping the ridges, it would be necessary to start from some point on the lower ground at their base. This neighbourhood, being of easy access from Mackay, and being apparently less disturbed by intrusions than other areas, offers the best inducement to prospecting. There cannot be more than 200 or 300 feet of strata likely to contain coal, since below this depth the beds of basalt, found outcropping further down the creek, may be expected to be met with, and will almost certainly have destroyed any coal that once existed at that depth.

Another area that offers some inducement to prospecting is the lower ground under the hills north of the Pioneer, between Mount Toby and Mount De Moleyns. The base of the siliceous sandstone is here easily traced, along the hills flanking the river to the north, forming a well-marked line falling lower and lower as it is followed to the east.

II.—COPPER AND SILVER ORE AT MOUNT FLORA.

Mount Flora is a low range of hills on Oxford Downs Run, and is situated on Bee Creek, a tributary of Funnel Creek, which runs into the Connor's River. The two latter streams drain the western fall of the coast range between Mackay and St. Lawrence, and flowing in a southerly direction along the range join the Isaacs and subsequently the Fitzroy. The lodes are situated on freeholds Nos. 1136, 1749, 634, and 1140, which were acquired some thirty years ago under the old mining laws of that date.

Communication is had with the coast at Mackay, *viâ* Nebo and Eton, entailing 70 miles by road to the foot of the coast range at Eton, and 24 miles, by rail from there to Mackay. The first 30 miles is over level country, which affords a good road in dry weather, but is reported to be almost impassable in the wet, some miles of it being over black-soil downs, and flat sandy alluvial country. The next 30 miles to the top of the range is rough and hilly. The road from the summit of the range into Eton falls with an even and easy grade, has been well constructed, and is in excellent order.

Geology and Character of the Ore.

The country rock of the hills in which the lodes occur is composed of highly inclined slates and shales. In close proximity are masses of coarse biotite granite. On the southern side of Mount Flora exploratory work, consisting of two short tunnels and a few shallow shafts and open-cut workings, has been done on several parallel lodes, which strike in a northerly direction into the hill and underlie steeply to the east. The strike of these lodes is conformable with that of the slates in which they are found, the lode material occurring in lenticular-shaped deposits between the bedding planes of the slates. On the northern side of the hill workings of a similar character are also found, on what is known as the Wallaroo Lode, and on O'Grady and Party's Claim. A great portion of this work was done over thirty years ago, and has tumbled in or become too dangerous to inspect. Within the last twelve months, however, the proprietors of the Freeholds have resumed work on some of the lodes, and have despatched to various smelting works some 130 tons of ore. Ore purchase notes from the Smelting Company of Australia of the last 70 tons 19 cwt. of this ore, sent between 13th December and 10th

GEOLOGICAL SKETCH MAP OF THE COUNTRY NORTH OF PIONEER RIVER

To Accompany Report on

ADDITIONS TO THE GEOLOGY OF THE MACKAY AND BOWEN DISTRICTS.

BY

WALTER E. CAMERON,

Assistant Government Geologist.

1903

Scale 2 Miles to an Inch.

A. McLaren Del.

INDEX TO COLOURS & SIGNS.

RECENT	Superficial Alluvium.	
CRETACEOUS	Desert Sandstone	D
	Desert Sandstone, Trachitic Lavas & Tuffs	Tr
PERMO-CARBONIFEROUS BOWEN RIVER BEDS	Siliceous Sandstone	Sa
	Coal Bearing Strata with interbedded Basalt	Sa Sh Ba
	Volcanic Tuffs, Conglomerate and even-bedded Sandstone	Tu
	Greywackes and Quartzites	Q
	Granite and Felsite	G

PARISH OF ZAMIA

PARISH OF ALLIGATOR

PARISH OF ST HELENS

PARISH OF OSSA

PARISH OF PELION

PARISH OF HAMILTON

PARISH OF HAMPDEN

PARISH OF BASSETT

PARISH OF HOWARD

PARISH OF GREENMOUNT

EASTERN FRONT OF COAST RANGE

BOWEN MACKAY ROAD

RESERVE FOR TOWNSHIP PURPOSES

RESERVE FOR PUBLIC PURPS

RESERVE FOR TOWNSHIP

TOWN RES

CAMPING RESERVE

TOWN OF MIRANI

TOWN OF ROTHESAY

Village of St Helens

Village of Murrinda

Village of Hilsborough

WALKERSTON

MACKAY

RAILWAY

PIONEER RIVER

MANGROVE SWAMP

Cape Hilsborough

Rocky Bluff

Finlayson's Point

HIGH RED CLIFFS

RABBIT I

OUTER NEWRY I

INNER NEWRY I

ACACIA I

MAUSOLEUM I

PORT NEWRY

Slade Pt

AMHURST

Rocky Islet

Reef

East Pt

FLAT TOP I

ROUND TOP I

MT CATHERINE

MT PELION

MT OSSA

MT SWEETLAND

MT JUKES

MT BLACKWOOD

MT ROY

MT OMEGA 2500 FT

MT DALRYMPLE 4255 FT

MT DE MOLEYNS

MT TOBY

MT BASSETT

Coal Outcrop

Ironstone Bed

Shales & Sandstones

Volcanic Tuffs & Conglomerates

Horizontal Sandstones age undetermined

White Cliffs

Soundings in feet

Tiger Ck

Zamia Ck

New Bore Ck

Alligator Ck

Catharine Ck

Blackrock Ck

Junction Ck

Sandy Ck

Barren Ck

St Helen's Ck

Carey's Ck

Surprise Ck

Niddoes Ck

Kilby's Ck

Johnmont Ck

Rowbuck Ck

Macarthey Ck

Macquarie Ck

Johnbull Ck

Palm Tree Ck

Constant Ck

Nelson's Ck

Habana Mill

Ashburton Mill

Fairleigh Mill

Beaconsfield Mill

Racecourse Mill

Marian Mill

Pleystowe Mill

Mandurana

Ninda Rod Mill

Scrubby Ck

Baker's Ck

Grassy Ck

Cattle Ck

Sybil Ck

Boulder Ck

Finch Hatton Ck

Murray Ck

Palm Tree Ck

Mc Gregor's Ck

Devereux Ck

Bolingbroke Ck

Seaforth Ck

Victor Ck

Mulgrave R

Macartney's Gap

Niddoes Gap

Mc Gregor's Gap

Mullard's Shaft

Sa Sh Ba

Sa

G

Tu

Q

D

Tr

June last, show copper values ranging from 20 per cent. to 30 per cent., and silver values of from 7 oz. to 11 oz. per ton. The average net value of this ore, as paid for by the works at the ruling prices for copper and silver at that time, has been £9 10s. 6d. per ton, the minimum being £8 3s. 5d. per ton, and the maximum £14 7s. 6d. Deductions for smelting charges, £1 7s. 6d. per ton; shipping and charges averaging £1 2s. per ton; and cartage to port, £2 10s. per ton; total, £4 19s. 6d., have left a margin of about £4 10s. per ton on the average and £3 3s. per ton on the lowest value ore. This ore has all come from within 60 feet of the surface, and has consisted mainly of carbonate and gossan ores, and in the case of the later and lower value ores of semi-oxidised sulphides.

Details of Work Done.

The major portion of the recent work has been done on the south side of Mount Flora on Freehold No. 1136. The most western of the lodes was here worked open cast on the side of the hill in the early days, and a tunnel along the lode, in extension of this work, has been put in 100 feet, and two winzes sunk to 50 feet and 30 feet at distances of 18 feet and 87 feet respectively. The old open-cast workings have been partially filled in so that the lode left underfoot cannot be seen. In the tunnel and in the first winze little ore was obtained, and at the end of the tunnel only a trace of ore is seen. In the second winze, however, good solid ore, varying from 1 foot to 2 feet in thickness, is seen down the sides, and also at the bottom, where it has been excavated for a few feet on either side. The ore occurs as a well defined and solid body of copper pyrites between walls of slate, and is evidently a lenticular patch occurring along the bedding planes. The greater portion of the 70 tons 19 cwt. referred to above, came from this winze, the last lot of 11 tons from the bottom being paid for by the smelting works at the rate of £8 3s. 5d. per ton, and showing 22·7 per cent. of copper and 8 oz. of silver to the ton. The ore left in the shaft is nearly pure chalcopyrite.

Further up the hill from these workings a shallow shaft has been sunk on a second ore body. I was unable to get down, but apparently the lode was small. A third lode, some 100 yards to the east, was formerly worked in shallow open workings, which have now fallen in. On a fourth, still further to the east, a short tunnel was driven, and ore taken out, and recently a shallow shaft has been sunk near the entrance to the tunnel. Neither could be inspected. On Freehold No. 1749 a strong looking lode can be traced on the surface for about 5 chains. About 5 feet of gossan and carbonate ore of low quality is exposed on the southern end, and higher up the hill at the northern end, about 1 foot of the same ore is seen.

On the northern side of Mount Flora, the Wallaroo workings show evidence of a considerable amount of surface work having been done, which has however fallen in. At O'Grady's shaft about 5 tons of ore, consisting of surface gossan ores, have been bagged from a narrow vein dipping flatly to the east.

Conclusion.

These ore deposits at Mount Flora do not give evidence, as far as they have been developed up to the present, of being of sufficiently large extent to warrant any great expenditure being undertaken in opening them out, or in the erection of reduction works to deal with the ore. The manner of occurrence of the ore, as lenticular bodies in the slates, and the high returns obtained from the sulphide ore extracted in some of the more recent work, the poorest of which has left a margin of £3 3s. per ton to pay for mining expenses alone, is, however, certainly an encouragement to further prospecting, in the hope that larger bodies may be disclosed. So far the work done has proceeded on the lines of extracting the best of the ore with the least possible trouble, and with no provision for further prospecting. I should recommend that, in order to more efficiently prospect the lodes, the ore body disclosed in the

second winze in the tunnel described above should be sunk on to a further depth of 100 feet or more, and if still showing good prospects, driven on in either direction. The fourth lode described above should also be worth sinking on, and also that found outcropping on Freehold No. 1749. Judging from the manner of occurrence of these lodes it is quite possible that, though small on the surface, they may with depth open out into important bodies, and in any case, if properly undertaken, sufficient ore could probably be obtained within the first 100 feet to pay for any prospecting to that depth.

III.—SILVER, LEAD, AND COPPER ORE AT MOUNT BARKER.

These lodes were fully reported on by Mr. Jack in July, 1893, but the report being a private one was never published.

At the time of Mr. Jack's visit two shafts had been sunk on the lead lode at a distance of about 2 chains apart—one to a depth of 83 feet, and the other to a depth of 25 feet. Since that time a third shaft (Shaft B) has been sunk between these two, and has been connected with the first shaft (Shaft A) at the 83-feet level by a drive along the lode. The second shaft (Shaft C) has been sunk a further depth of 50 feet, making 75 feet in all, and a fourth shaft (Shaft D) has been sunk on the lode 178 feet beyond Shaft C to a depth of 48 feet. As Shafts A and C could not be descended, and B only as far as the water-level, little information additional to that given by Mr. Jack could be gained as to the value of the ore body, Mr. Jack's report is consequently given verbatim. The accompanying plan shows the shafts and crosscuts referred to by Mr. Jack, and the work done since his visit. Apparently no great quantity of ore has been stoped out.

REPORT ON THE MOUNT BARKER SILVER MINES.

By Robert L. Jack, Government Geologist.

Mount Barker is the name given to an insignificant elevation on the dividing ridge between the Broken River and Hazlewood Creek, about 3 miles north-west of Eungella Station. The Mount Barker mines are on the south-western or Hazlewood Creek fall of the divide.

The country rock consists of greywackes and quartzites. The former are occasionally gritty, and the included fragments are in some cases angular. In this respect they resemble some of the grits peculiar to the "Gympie Formation," the lowest subdivision of the Permo-Carboniferous System of Queensland. It would, however, be rash, on such evidence alone, to assign a definite age to the rocks in question.

There are practically two lodes on the property. That which has the more conspicuous cap runs from north-east to south-west. The other makes its appearance a little south of the point where the first ceases to be conspicuous on the surface, and has a course a few degrees south of south-west.

The cap of the larger, which is distinguished as the "Lead Lode," is continuous for a distance of 6 chains, and for about two-thirds of this distance is very conspicuous, standing up in places to a height of 8 feet or 10 feet above the general level of the ground. It measures 36 feet across at its widest, about 20 feet south-west of shaft C, and about 15 feet an equal distance north-west of the same shaft. The cap diminishes in width rapidly both to north-east and south-west. At the south-western end two distinct outcrops of lode-matter are to be seen; but whether this indicates a splitting-up or a second widening of the lode can only be determined by trenching to ascertain whether the intervening distance of about 20 feet is occupied by country rock or lode-matter. The cap of the lode is composed, for the most part, of siliceous, with an admixture of felspathic material, the whole being more or less ironstained. When broken up it occasionally displays galena or lead oxide, and sometimes stains of copper carbonate. From the fact that the cap presents a cliff or escarpment to the north-west over the greater part of its length, it may be inferred that the lode has a hade or underlie to the south-east.

Lode-matter (silica with lead oxide) is seen in the gully about 36 feet north-east of shaft A, and again about 550 feet north-east of the gully, near the hut on the top of "Mount Barker."

The lode has been opened up in two shafts, which may be named A and C respectively, the former being 36 feet south-west of the gully, and the latter 136 feet further to the south-west (*see* Plan). Several shallow trenches have also been cut across portions of the lode.

Shaft A is 83 feet in vertical depth. As the shaft commences on the cap, and at successive levels crosscuts have to be carried to the south-east to meet the lode, an underlie to the south-east is sufficiently established.

A crosscut to the south-east from the bottom of the shaft first traverses a country-rock of hard gritty greywacke, with distinct stratification, dipping at 25 degrees to the south. Near the lode a system of vertical jointing is induced in the country-rock, parallel to the lode. Eleven feet from the shaft the clean-cut wall of the lode is met with. This must be regarded as the footwall, although locally it is vertical. Commencing at the footwall, the following is a section of the lode as uncovered in the crosscut: —

	Ft. In.
Quartzose gangue	0 in. to 6 in.
Vertical vein of fine-grained galena (sample 20)	1 3
Quartzose and clayey gangue, tolerably solid, with spots of galena	1 3
Scamy contorted clayey gangue	6 in. to 10 in.
Quartzose gangue with clay joints. At the face of crosscut a thin vein of galena and zinc-blende (sample 21)	1 0

The crosscut has not reached the hanging-wall of the lode.

The samples selected were assayed on my return to Brisbane by Mr. J. B. Henderson, Government Analyst, with the following result:—

No. 20	Silver	47 oz. 10 dwt. 14 gr. per ton
	Lead	71·3 per cent.
No. 21	Silver	19 oz. 5 dwt. 11 gr. per ton
	Lead	52·8 per cent.

At the 60-feet level, a crosscut to the south-east, after traversing 11 feet of country-rock similar to that in the bottom level, cuts an igneous rock, a felstone with a base of acidic felspar and blebs of quartz—probably a dyke—1 foot in thickness, which is succeeded by the lode. The latter, measured from the north-western or footwall, has the following section:—

	Ft. In.
Ore, chiefly zinc-blende, with some galena	0 3
Much-jointed siliceous gangue	1 0
Quartz, with specks of galena and pyrites	0 6
Galena, fairly solid, with a little quartz and zinc-blende (sample 22)	1 8
Siliceous gangue, with spots of galena, pyrites and zinc-blende ...	1 0

The face of the crosscut is in hard greywacke country-rock.

Sample No. 22 gave on assay:—

Silver	47 oz. 13 dwt. 20 gr. per ton
Lead	73·4 per cent.
Zinc	6·8 „

A level is carried for 20 feet to the south-west from the end to the crosscut. The roof of the level exposes a vein of pure fine-grained galena, averaging about 8 inches in thickness (sample No. 23, from south-west face of level). This sample assayed:—

Silver	58 oz. 2 dwt. 22 gr. per ton
Lead	65·8 per cent.

At the south-western face of the level (on the south-east side) a new make of galena, pyritous and antimonial, 4 inches thick (sample No. 24) comes up to quartz vein, the latter being in contact with hard country-rock. This new make is about 15 inches apart from the 8-inch vein of galena, which latter, as far as I could judge, is, at the face, adjacent to the footwall. Sample No. 24 assayed:—

Silver	59 oz. 15 dwt. 4 gr. per ton
Lead	45·7 per cent.
Antimony	a trace.

At the 30-feet level, a crosscut is carried to the south-east for 6 feet to the lode. The lode is here 5 feet in width, and has, in addition to veins in which arsenical and copper pyrites predominate over galena, one vein, about 15 inches thick, of nearly solid ore, in which sometimes

zinc-blende and sometimes galena predominates. A sample (No. 25) and another (No. 26) were selected, and gave on assay :—

No. 25	Silver	10 oz. 5 dwt. 19 gr. per ton
	Lead	25·3 per cent.
	Zinc	31·7 „
No. 26	Silver	10 oz. 2 dwt. 12 gr. per ton
	Lead	22·8 per cent.
	Zinc	30·5 „

At the mouth of the shaft is a heap of ore, said to have come from the 60-feet level. I estimate the quantity at 10 tons, although it must be observed that the estimate is only approximate, being based on measurements and an assumed specific gravity. The heap consists of fairly solid galena, varying from fine to coarse grained, sometimes a good deal mixed with pyrites, and containing a little zinc-blende. Three samples (Nos. 15, 16, and 17) were taken, each composed of small fragments from all over the heap. They assayed as follows :—

No. 15	Silver	41 oz. 6 dwt. 11 gr. per ton
	Lead	48·4 per cent.
	Zinc	14·6 „
No. 16	Silver	51 oz. 12 dwt. 6 gr. per ton
	Lead	55 per cent.
	Zinc	15 „
No. 17	Silver	28 oz. 8 dwt. 9 gr. per ton
	Lead	48·6 per cent.
	Zinc	11·8 „

A quantity of similar ore was sent to the Queensland Smelting Company's Works at Aldershot, in March, 1891. The manager, on being authorised to do so by Mr. Richard Barker, kindly sent me a copy of the returns, which are here given :—

Weight	7 tons 16 cwt. 3 qr. 12 lb.
Assay, silver	46 oz. per ton
„ lead	56 per cent.

A second parcel of this ore was being bagged for transmission to the Dry Creek Works, South Australia, while I was on the ground. Mr. Auriol Barker has since favoured me with the results, viz. :—

Weight	3 tons 17 cwt. 2 qr.
Assay, silver	31 oz. per ton
„ lead	37 per cent.

A heap of small débris, the dressings of the other heap, I estimated to contain about 30 per cent. (by bulk) of ore, and 70 per cent. of gangue, and to amount to about 16 tons. Samples Nos. 19 (18? W.E.C.) and 20 (19? W.E.C.) were carefully selected to average the heap, and assayed :—

No. 18	Silver	27 oz. 8 dwt. 19 gr. per ton
	Lead	36 per cent.
	Zinc	9 „
No. 19	Silver	29 oz. 1 dwt. 11 gr. per ton
	Lead	32·4 per cent.
	Zinc	13·2 „

or a combined average of 28 oz. 5 dwt. 3 gr. of silver per ton.

Shaft C is 25 feet. At 10 feet there is a vein of ore 2 feet in thickness, consisting mainly of galena, with some sulphate of lead. A sample, No. 9, assayed :—

Silver	24 oz. 10 dwt. per ton
Lead	45·1 per cent.

This ore-body has a slight underlie to the north-west at 10 feet from the surface, but becomes nearly vertical at the bottom of the shaft.

Six feet from the bottom a drive is carried for 6 feet to the north-west of the shaft through lode-matter, with small "horses" or "blocks" of country-rock. The lode-matter is mixed up with a little galena in spots and veins, including one lump (at the face), perhaps 18 inches in diameter, consisting of galena to the extent of, say, one-third (by bulk). A sample, No. 8, from this lump assayed :—

Silver	30 oz. 10 dwt. 20 gr. per ton
Lead	36·6 per cent.

The bottom of the shaft shows lead ore (galena) on the south-eastern side, and veins and lumps of galena, varying up to 18 inches square, in section. A sample, No. 10, of one of these lumps assayed :—

Silver	...	...	...	40 oz. 16 dwt. 16 gr. per ton
Lead	...	...	...	77·6 per cent.

The bulk of the lode must lie to the north-west of the shaft.

A ton of ore from this shaft was sent to Aldershot. Mr. Webster, of Mackay, showed me the assay returns, dated 14th April, 1893, which were :—

Silver	...	...	...	46 oz. per ton
Lead	...	...	...	68 per cent.

The ore, worth £6 12s. 4d. per ton.

A heap of undressed ore, perhaps 50 tons, lies at the mouth of the shaft. It may contain one-third (by bulk) of pure ore, consisting of galena and sulphate of lead, with a little carbonate of lead. I saw no means of arriving at the value of this heap without turning it bodily over. Instead of attempting to do so, I took samples of distinct classes of ore, which were numbered and subsequently assayed, as follows :—

No. 4.—(Picked carbonate of lead and sulphate).

Silver	...	...	...	72 oz. 3 dwt. 20 gr. per ton
Lead	...	...	...	68·9 per cent.

No. 11.—(Galena with sulphate of lead).

Silver	...	...	...	24 oz. 10 dwt. per ton
Lead	...	...	...	37·4 per cent.

No. 12.—(Small plumbiferous and ferruginous débris).

Silver	...	...	...	18 oz. 12 dwt. 9 gr. per ton
Lead	...	...	...	30·7 per cent.

A trench about midway between shafts A and C exposes about 3 feet of the cap of the lode on its south-eastern or hanging-wall side. The trench has not been carried far enough to touch the other wall. About 6 inches of the portion of the lode exposed in the trench is fairly solid galena and sulphate of lead, with a little antimony sulphide. A sample, No. 14, assayed—

Silver	...	...	...	17 oz. 19 dwt. 8 gr. per ton
Lead	...	...	...	51·2 per cent.
Antimony	...	...	...	a trace.

About 1 chain south of shaft C a shallow hole has been sunk on a vein, 1½-inch thick, showing decomposed lead and copper ores. The vein underlies to the south-east.

The "Copper Lode" has been opened on in three shallow shafts—D1, D2, and E. The first, or northmost (D1), is only 3 feet in depth. About 20 lb. of "ore" from this excavation are lying at grass. The ore contains perhaps ¼ lb. of galena, in addition to some iron and maganese oxides and a very little carbonate of lead.

Shaft D2, 30 feet to the south-west, has also only broken the surface. It shows a lode consisting mainly of yellow ferruginous, siliceous, and felspathic gangue, slightly copper stained. About 1 ton of gossany ore is lying at grass. It is iron and manganese stained, with some lead and antimony oxide, and specks of galena passing into sulphate of lead. Sample No. 3, taken with a view to average the heap, assayed :—

Silver	...	...	...	6 oz. 17 dwt. 4 gr. per ton
Copper	...	...	...	0·95 per cent.
Antimony		...	...	under 2 per cent.
Lead	...	...	...	a trace.

Shaft E, 55 feet further south-west, is 30 feet deep. In the face of a drive, 8 feet to the north-east of the bottom of the shaft, the lode is 18 inches wide, between walls of hard country-rock. It contains strings and veins of ore, to the extent of perhaps one-third (in bulk). The largest vein of ore is about 1½ inches thick. A sample, No. 7, from this vein assayed :—

Silver	...	...	...	80 oz. 0 dwt. 16 gr. per ton
Copper	...	...	...	12·5 per cent.
Antimony		...	...	under 1 per cent.
Lead	...	...	...	a trace.

The lode appears to have a slight underlie to the north-west.

At the bottom of the shaft (north-east end) the lode is about 30 inches wide, the gangue being very hard and siliceous. It contains a soft black vein of mixed sulphate and oxide of copper, of which a sample, No. 5, assayed :—

Silver	66 oz. 19 dwt. 8 gr. per ton
Copper	13·8 per cent.
Antimony	under 1 per cent.
Lead	a trace.

At the south end of the shaft, 3 feet from the bottom, a soft ferruginous and cupreous ore goes across the shaft between the walls. A sample, No. 6, assayed :—

Silver	71 oz. 17 dwt. 8 gr. per ton.
Copper	5·9 per cent.
Lead	a trace.

From this point down, copper pyrites replaces the oxidised ores.

Two heaps of ore are lying at the mouth of shaft E. The first is called "peacock ore," and is a mixture of quartz, blue carbonate of copper, copper pyrites, and "title ore" (ferruginous red oxide of copper), with a very little galena. The heap might amount to 18 tons. Seventeen hundredweight of this ore had recently been sent to Aldershot, and Mr. Webster showed me the returns (dated 14th April, 1893), viz.:—

Silver	104 oz. per ton
Copper	14 per cent.

Value, £12 7s. per ton.

To average the heap, I selected samples Nos. 1 and 2, composed of fragments taken from all over it. They assayed :—

No. 1	Silver	85 oz. 5 dwt. 4 gr. per ton
	Copper	13·4 per cent.
	Lead	a trace.
No. 2	Silver	85 oz. 8 dwt. 11 gr. per ton
	Copper	16·7 per cent.
	Lead	a trace,

or a combined average of 85 oz. 6 dwt. 19 gr. of silver per ton.

A parcel of ore was being prepared for transmission to Dry Creek, South Australia; Mr. Auriol Barker has since communicated the result, which is as follows :—

Weight	2 tons 16 cwt. 3 qr.
Copper	13 per cent.
Silver	82 oz. per ton.

The second heap consists of perhaps one-fourth (by bulk) of lead ore (sulphide, sulphate, and carbonate), the remainder being matrix or gangue. The heap may contain 44 tons in all. A sample, No. 13, assayed :—

Silver	21 oz. 14 dwt. 11 gr. per ton
Lead	39·2 per cent.

For convenience of reference, the assays of the silver-contents, and analyses of the lead, copper, antimony, and zinc contents made for me by Mr. J. B. Henderson, Government Analyst, are tabulated in the Appendix.

The "Lead Lode" is large, and gives every indication of being capable of furnishing great quantities of ore rich in lead, and containing silver which would likely average at least between 30 and 40 oz. to the ton, an average about equal to that of Broken Hill. Oxidised ores or carbonates do not appear to extend to any depth, and the mine may almost be said to commence with the sulphide stage, so that a deterioration in the quality of the ore need not be apprehended, unless the presence of zinc should render the recovery of the silver-contents difficult. A simple argentiferous galena is easy to treat, and in an ore of this class, so rich in lead as that of Mount Barker "Lead Lode," the lead would probably pay for raising and smelting. I observe from the reports of the Broken Hill Proprietary Company that a "sulphide ore," averaging 27·75 per cent. of lead, 20·5 per cent. of zinc, and 22 oz. of silver per ton, is reckoned an ore not difficult to deal with; whereas the silver- and lead- contents of the "Lead Lode" are considerably higher, and the zinc-contents vary from 9 to 15 per cent. (*i.e.*, eliminating assays Nos. 25 and 26, which are from a vein chiefly composed of

zinc-blende). The cost of treatment per ton of ore at Broken Hill is given in the same report (31st May, 1891) at £1 16s. 10d., equal to 13½ oz. of silver at the present low price of 2s. 9d. per oz. To this there has to be added the cost of raising, dressing, and carriage.

The "Copper Lode" is much richer in silver, clean copper pyrites giving assays of from 67 to 85 oz. per ton, but I am not so sure of the permanence of the lode, which, at the bottom of the deepest shaft, is somewhat "rock-bound" in hard country. It need not, however, be concluded that the lode has been fairly tried, for it has not, and it would be worth while to sink sufficiently to prove the continuance of a body of ore so rich in silver. From an ore of this class the silver and copper are both recoverable, but it would probably pay best to export the dressed ore at first. An idea prevails in some quarters that the lead ore might assist in the recovery of the silver from the copper ore, but the processes depending on smelting or heating copper ores with the addition of lead have been much discredited of late years, as the loss of silver is found to be excesssive. The two classes of ore will, in fact, have to be kept and dealt with apart.

ROBERT L. JACK.

Geological Survey Office.
Brisbane, 20th July, 1893.

APPENDIX—ASSAYS AND ANALYSES.

No.	Locality, Quality of Ore, &c.	Silver per Ton.	Lead.	Copper.	Antimony.	Zinc.
		Oz. dwt. gr.	Per cent.	Per cent.	Per cent.	Per cent.
	The "Lead Lode."					
25	Shaft A, 30-feet level, S.E. crosscut from shaft, 15-inch vein zinc-blende and galena	10 5 19	25·3	...	...	31·7
26	Do. do. (same vein) ...	10 2 12	22·8	...	...	30·5
22	Do. 60-feet level, S.E. crosscut from shaft, 20-inch galena vein	47 13 20	73·4	...	...	6·8
23	Do. 60-feet S.W. level, 8-inch galena vein	58 2 22	65·8			
24	Do. 60-feet face of S.W. level, 4-inch galena vein	59 15 4	45·7	...	trace	
15	Do. heap of ore at surface, from 66-feet level	41 6 11	48·4	...	...	14·6
16	Do. do.	51 12 6	55·0	...	...	15·0
17	Do. do.	28 8 9	48·6	...	...	11·8
18	Do. do. (dressings of 15, 16, 17)	27 8 19	36·0	...	...	9·0
19	Do. do. do. ...	29 1 11	32·4	...	...	13·2
20	Do. (bottom), 83-feet crosscut, to S.E.—15-inch vein fine-grained galena	47 10 14	71·3			
21	Do. (bottom), 83-feet crosscut to S.E.—12-inch vein galena and zinc-blende	19 5 11	52·8	...	...	not estd.
14	Trench between shafts A and C ...	17 19 8	51·2	...	trace	
9	Shaft C at 10 feet deep, 2-feet vein of ore	24 10 0	45·1			
8	Do. at 19 feet deep, crosscut to N.W.	30 10 20	36·6			
10	Do. bottom (25 feet)	40 16 16	77·6			
11	Do. heap of ore at mouth—galena and sulphate of lead	24 10 0	37·4			
4	Do. heap of ore at mouth—picked carbonate of lead	72 3 20	68·9			
12	Do. do. (dressings of 4 and 11)	18 2 9	30·7			
	The "Copper Lode."					
3	Shaft D2, heap of gossany ore ...	6 17 4	trace	0·95	under 2	
6	Shaft E, at 27 feet deep, S. end of shaft	71 17 8	trace	5·9		
5	Do. bottom (30 feet), N.E. end of shaft, 3-inch soft black vein	66 19 8	trace	13·8	under 1	
7	Do. drive, 8 feet N.E. from bottom 1½-inch vein	80 0 16	trace	12·5	under 1	
1	Do. first ore heap ("peacock ore") at mouth	85 5 4	trace	14·3	trace	
2	Do. do.	85 8 11	trace	16·7		
13	Do. second ore (lead ore)	21 14 11	39·2			

Before Mr. Jack's visit, about 10 tons of lead ore had been sent away to various purchasers, and since his visit another 30 tons have been despatched. The returns from this ore are given in the accompanying table. The table shows that the average of lead percentage given by Mr. Jack's samples has been well maintained in the bulk ore, but the amount of silver per ton has decreased slightly. The zinc percentages are not given in these returns, but the results obtained by Mr. Jack, showing a variation of from 9 per cent. to 15 per cent., are not excessive. The blende is in most cases coarse and massive, and no doubt much of it could be easily separated by hand-picking the ore. The real question is the amount of ore likely to be available if systematically mined, and this question the present condition of the mines gives little opportunity of answering. Mr. Jack expressed the opinion that the lode "gives every inclination of being capable of furnishing great quantities of ore rich in lead, and containing silver which would likely average between 30 oz. and 40 oz. to the ton." In Shaft A there is evidently a good body of ore in the two lower levels, and also in Shaft C at the 25-feet level. In Shaft B there is showing about 18 inches of galena and carbonate ore at the 30-feet level. The bottom of the mine, however, could not be inspected. In opening out the mine again the level connecting Shafts A and B should be driven further to the south-west under Shaft A, and the continuance of the lode in this direction thoroughly prospected, for in Shaft D only a thin vein of galena is showing, and the lode seems to be thinning in this direction.

The tunnel put in to cut the copper lode at 60 feet below the Shaft E has not disclosed any important body of ore, though at one point a small vein of fairly rich carbonate is said to have been met with. This vein was opened out on for a few feet, but subsequently abandoned.

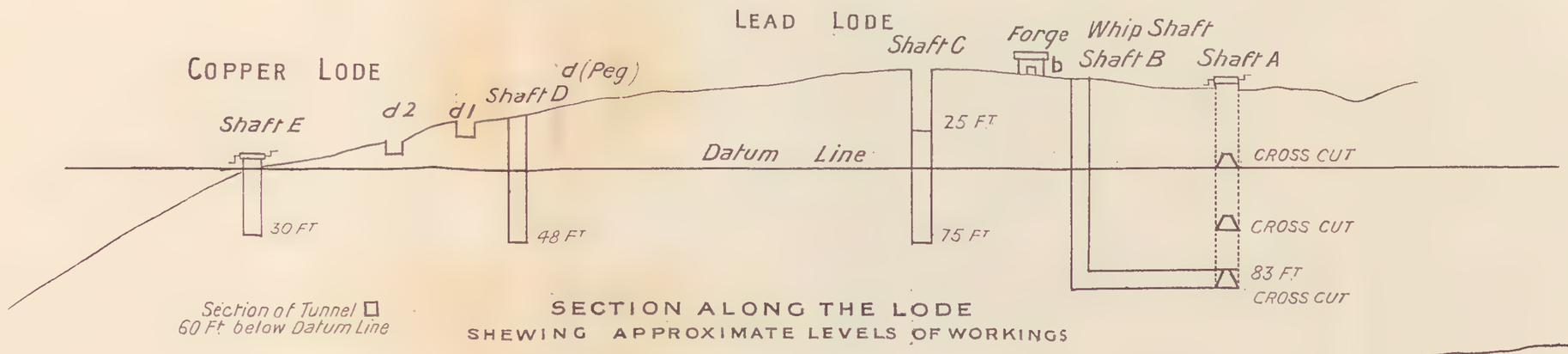
TABLE SHOWING AMOUNTS AND VALUE OF PARCELS OF ORE SENT FROM MOUNT BARKER MINE.

—	Amount of Ore	Value per Ton.	Price of Silver.	Price of Lead.	Silver—Oz. per Ton.	Lead—per cent.	Dwt. Silver to unit of Lead in Ore.	Smelting Charge.
	Tn. cwt. qr. lb.	£ s. d.	s. d.	£ s. d.	Oz. dwt. gr.		Dwt.	£ s. d.
March, 1891 ...	7 16 3 12	...	...	...	46 0 0	56	16·4	
	3 17 2 0	...	...	...	31 0 0	37	16·8	
April, 1893 ...	0 14 2 7	12 8 0	...	...	46 0 0	68	13·5	3 0 0
June, 1895 ...	1 19 0 2	10 3 0	...	...	29 6 0	67·35	8·7	3 5 0
August, 1895 ...	5 11 0 17	10 12 8	2 8⅞	10 17 6	30 19 6	61·70	10·3	
February, 1897 ...	19 6 2 3	10 6 3	2 8	11 15 0	26 17 0	54·4	9·9	3 10 0
Averages and Totals	39 5 2 13	...	...	...	35 0 9	57·4	12·6	

IV.—THE EUNGELLA GOLD FIELD.

No serious mining has been done on this field since 1896. None of the mines were open to inspection, and little direct information could be obtained as to the value of the reefs. The following information has been extracted from the warden's reports of past years.

The field was proclaimed in 1889, when 30 chains and 13 protection areas were registered, and 180 to 200 people were estimated to be on the ground. By the end of 1890 a 10-head battery (now standing idle on the north bank of the Broken River) was in course of erection to deal with stone from the Orchid Claim, the prospecting claim on the main line of reef, and situated a few chains north of the battery. In 1891 the population had dwindled to 49. The Orchid P.C. reef was reported to be 5 feet in width, the gold-bearing stone, however, being confined to a vein of 6 inches on the



SECTION ALONG THE LODE
SHEWING APPROXIMATE LEVELS OF WORKINGS

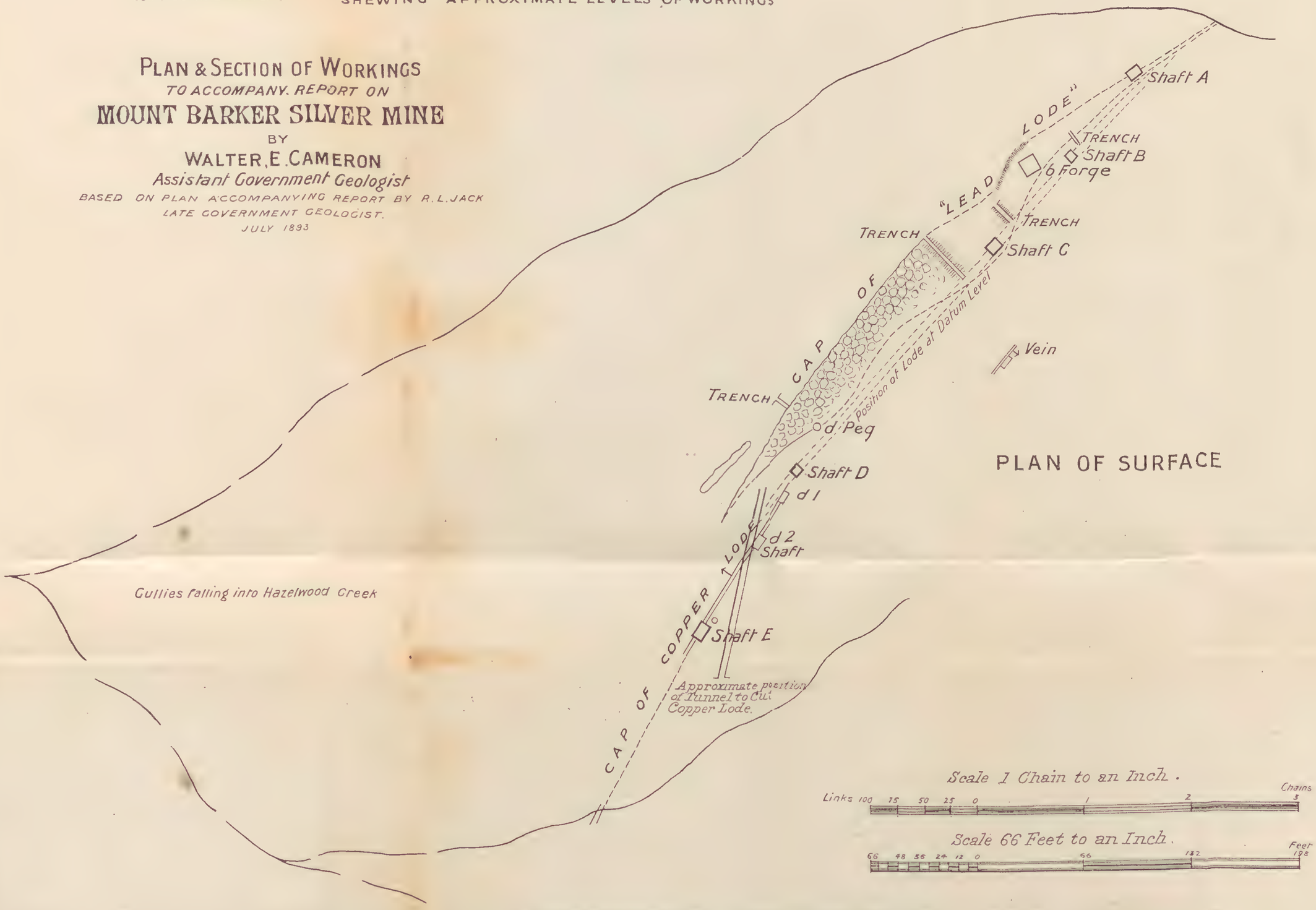
PLAN & SECTION OF WORKINGS

TO ACCOMPANY REPORT ON

MOUNT BARKER SILVER MINE

BY
WALTER, E. CAMERON
Assistant Government Geologist

BASED ON PLAN ACCOMPANYING REPORT BY R. L. JACK
LATE GOVERNMENT GEOLOGIST.
JULY 1893



PLAN OF SURFACE

Scale 1 Chain to an Inch.

Links 100 75 50 25 0 1 2 Chains 3

Scale 66 Feet to an Inch.

66 48 56 24 12 0 66 132 Feet 198

By Authority: G. A. VAUGHAN, Government Printer, William street, Brisbane.

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footwall. One shaft on the Lady Norman P.C. was down 70 feet, and 86 tons of stone raised. The Gladstone P.C. had raised 60 tons of stone, the best of which was dollied. Three hundred and seventy-five ounces 1 dwt. of gold were purchased on the field.

In 1892 the Orchid P.C. was the only claim being worked, but it was not on payable stone. In August, 1893, it passed into the hands of the Eungella Gold Mining Company, and paid £1,875 in dividends during the first half of the year, 1894, when the payable stone cut out. After continued prospecting it shut down in 1896, and has apparently not been seriously mined since. The returns of the crushings are not given in the warden's report.

During 1895 and 1896 the principal mining was on the Lady Norman Mine, south of the township, from two shafts about 70 feet deep—one on the P.C. and the other on the No. 1 North or Gracie Norman Claim. On the Canadian P.C. 60 tons were raised from a 70-feet shaft, and from the Day Dawn adjoining the Canadian on the south 48 tons gave a return of 13 dwt. to the ton.

In December, 1896, the Lady Norman Mine crushed 82½ tons for a return of 114 oz. 15 dwt., but the crushing from the No. 1 North (the Gracie Norman) was poor. No mention is made of these mines in the annual report for 1897, and apparently no mining of any consequence has been done since the above two crushings were put through.

On the Bee Creek Diggings, about 10 miles north of the main workings of the Eungella field, no work was being carried on. The reefs in this locality were reported on in detail by Mr. Maitland in 1889. The reefs are apparently small and heavily mineralised.

V.—COPPER AND SILVER ORE AT PINE VALE.

The Pine Vale lode is situated some 15 miles south of Mirani, about half-a-mile from the right bank of the Pioneer River. The outcrop is found running up a gorge, which cuts down the western side of the granite hills, which bound the river on its eastern bank. Up towards the head of the gorge the outcrop runs in under the precipitous southern bank, and a tunnel has been driven in here along the lode. The first 30 feet was driven under the débris of boulders from the side of the gorge, but the remaining 20 feet was on the lode. In the face the lode showed about 2 feet of solid white quartz standing vertically, and splashed through with specks and lumps of bornite and chalcopyrite. The lode is in biotite granite, but there is no well-defined wall between the two, the quartz shading off rapidly into the granite—being "frozen on" to the country, to use a miner's term. The tunnel was being driven by contract at the time of my visit at the rate of £1 15s. per foot, the driving being very hard. The ore is dressed on the surface by hand spalling to about 20 per cent. of copper value, and the dressed ore is shipped to smelting works. From the above 20 feet of driving on the lode, the following two parcels have been smelted, the returns of which were kindly supplied me by Mr. V. S. Dunn, of the Aldershot Smelting Works, where they were treated :—

—	Weight.	Gold per Ton.	Silver per Ton.	Copper per Cent.	Value per Ton at Mine.
	Tons cwt. qr. lb.	Dwt.	Oz.	Per cent.	£ s. d.
No. 1	1 11 1 16	2	6	21	8 5 8
No. 2	1 4 3 21	1	10	19·14	7 18 6

With efficient concentrating machinery it ought to be possible to bring this ore up to twice the above value, by getting rid of half its weight of quartz, so that a high-valued product could no doubt be easily obtained, which would

well pay for shipment to smelting works. The question of the quantity of ore of this quality available is, however, a somewhat more difficult one. The lode is not a large one, and the ore is only sparsely distributed through it, so that unless it can be expected to widen considerably as it is opened up, it will be difficult to keep down the expenses of mining sufficiently to make the erection of expensive crushing and dressing machinery a profitable undertaking. The outcrop of the lode can be traced for some chains down the gorge, to where it has been opened up by a shaft some 20 feet deep. This outcrop shows green carbonate associated with quartz. The lode is apparently an infilling of a joint plane of the granite with quartz and copper bearing minerals. There are no signs of movement of the walls of the lode, which has none of the features of a fissure vein. I am not very confident of the lode opening out to any great extent either in depth or when followed into the side of the gorge.

About 4 miles north of the Pine Vale lode are the Edith and Bong Bong lodes, but as all the shafts have tumbled in, and could not be inspected, little could be seen of their characters. They do not appear to have furnished any quantity of ore.

VI.—THE NORMANBY GOLD FIELD.

Work on the Normanby Gold Field was confined to three reefs—the Perseverance, Welcome Dick, and Highland Mary, the latter of which is a new discovery.

The Perseverance lies some 3 miles north of the township on the Bowen road, and strikes across the road in an east and west direction. A shaft on the top of a rise east of the road has been sunk through about 40 feet vertical to meet the reef which here dips steeply to the north. The shaft then follows the underlie down to a depth of 79 feet. A drive from the bottom goes west about 40 feet, and the reef has been stoped out to the surface for about 28 feet in. The remaining 12 feet in the drive shows from 6 inches to 1 foot of reef in about 3 feet of formation with well-defined walls. The formation is soft chlorite crushed granite. Behind the vertical shaft is an old underlie which followed the reef down from the cap. For the first 30 feet the reef was dipping steeply when it became flatter to the point where the vertical shaft meets it when it again turned over to its normal dip. The best stone is said to have come from where the reef was flat, the quartz occurring in numerous veins through the formation. At the present bottom of the shaft on the eastern side the reef is white and looks poor. It is up to 9 inches in thickness. The following crushings have been taken out:—

1898, August	...	5	tons	12	cwt.	gave 9	oz.	6 dwt. gold.
1901, October	...	21	„	14	„	44 „	5	„
1902, May ...	...	20	„	0	„	34 „	0	„

The Welcome Dick lies about a mile west of the Perseverance Mine. A shaft follows the reef, dipping steeply to the North for a distance of 90 feet, and at the time of the writer's visit the mine was being put in order again after being full of water for some years, and a level was being driven to the east, and was about 40 feet in. The reef showed very irregularly in the face, being hard bound in wall of country-rock, and running up to 1 foot in thickness. This stone was very heavily mineralised. The country-rock is almost a hornblende gneiss. The water was giving a great deal of trouble, the engine employed finding it as much as it could do to cope with. The following crushings have been obtained from this reef:—

In 1892, October	...	9	tons	17	cwt.	1 lb. gave	7 oz.	16 dwt. gold
„ 1893, May	...	30	„	16	„	3 „	33 „	7 „
„ 1893, December		20	„	3	„	0 „	22 „	14 „
„ 1894, April	...	10	„	12	„	3 „	13 „	3 „

The Highland Mary is a reef which has been lately found some 7 miles south-east from the township. It is in rough granite country, and outcrops on a spur coming down from higher hills to the west. The reef had scarcely been opened out at the time of the writer's visit, and was seen to be lying almost flat. It had been opened out by two trenches, which showed about 1 foot of quartz, with granite above and beneath. The reef, apparently not a true fissure, but seem to be segregation veins along a contraction parting in the granite, and to curve over as it is followed into the hill. The gold is coarse and easy amalgamable. About 5 or 6 chains further north is another vein of quartz of similar character. A crushing of 10 tons is reported to have given 50 oz. 10 dwt. per ton.

VII.—COAL AT BYERWIN STATION.

During September a visit was paid to Byerwin Station where a seam of coal had been struck at a depth of 60 feet in the station well. I was not able to get down the well as the windlass had been removed. The owner of the station, however, Mr. Ferguson, informed me that the coal occurred in bands of up to 6 inches in thickness, interbedded with bands of black stone. Some of this coal was being used in the shoeing forge and proved a good blacksmith coal. A sample taken from that on the surface gave the following analysis at the Government Chemical Laboratory:—

Analysis of coal from Byerwin Station well:—

Moisture	1·52 per cent.
Volatile hydrocarbons	22·47 „
Fixed carbon	61·17 „
Ash	14·84 „
Total	100·00 „
Sulphur	·405 per cent.
Evaporative power (as per calorimeter)	12·5 lb.

This analysis is indicative of the fact that coal of good quality exists in these beds, though so far no seam of workable thickness appear to have been met with. Byerwin Station is well under 100 miles from Bowen by the Sonoma and Mount Pleasant road, which would give a route easily negotiable by a railway. As such a railway would tap some of the finest black-soil country that Queensland possesses, the fact that such country is probably underlain by seams of good bituminous coal, and is within 100 miles of such a port as Bowen, is worth keeping in mind. Owing to the horizontality of the coal strata from Byerwin to the Bowen River, prospecting for coal seams will have to be done for the most part by boring, and will consequently be attended with considerable expense. In 1886 two Government bores were put down at Pelican Creek and Havilah respectively, the latter place some 20 miles north of Byerwin, both of which reached the base of the coal-bearing beds. The comparatively poor quality of most of the seams passed through, owing to the destructive action of numerous igneous intrusions, led to the abandonment of further prospecting. There is no saying, however, how much further south the effects of this igneous action may have extended, and possibly in the neighbourhood of Byerwin the coal may prove to be quite undisturbed.

[No. 181 of the Geological Survey Publications.]

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

VICTORIA

Queensland

DEPARTMENT OF MINES

GEOLOGICAL SURVEY REPORT No. 183.

RECENT MINING DEVELOPMENTS ON THE RAVENSWOOD GOLD FIELD.

BY

WALTER E. CAMERON, B.A.,

ASSISTANT GOVERNMENT GEOLOGIST

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BRISBANE:

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1903.

RECENT MINING DEVELOPMENTS ON THE RAVENSWOOD GOLD FIELD.

I.—INTRODUCTION.

The geology and reefs of the Ravenswood Gold Field were reported on in detail by Mr. J. M. Maclaren, late Assistant Geologist on the survey, in October, 1900.*

Since the date of Mr. Maclaren's report considerable developments have taken place at the old Donnybrook, now called Brookville, and also at the Kirk Diggings, but more especially in the Grant and Sunset Mines, near the town of Ravenswood. The Grant and Sunset Reefs, with the Black Jack and Shelmalier, were taken over in 1899, and have since been vigorously developed by an English company known as the New Ravenswood Company, Limited. The Erin's Hope and Donnybrook Reefs, at Brookville, were developed mainly by local capital, but, after giving handsome returns for three years, mining in this quarter has since received a check, owing to the loss of the Donnybrook through the faulting of the reef in the lower workings. The renewed attention to the Kirk is owing to the enterprise of two Charters Towers companies, which were formed to exploit the Morning Star and Himalaya Reefs.

II.—THE REEFS NEAR RAVENSWOOD.

The Sunset Reef.—Previous to the taking over of the workings on this reef by the New Ravenswood Company, the Sunset Reef had yielded—according to the records in the Warden's office—14,722 oz. of gold from 8,462 tons of stone, between the years 1870 and 1894. These amounts give an average of 1 oz. 14 dwt. 8 gr. of gold per ton of stone, which must be considered a very good result when the refractory nature of the ore and the consequent imperfect extraction of the gold are taken into consideration. Practically the whole of this stone came from the hanging-wall reef, which was worked to a vertical depth of 233 feet by means of a perpendicular shaft 109 feet, and a flat underlie; also for a horizontal distance of about 400 feet along the line of reef. The accompanying plan shows the workings on this reef shaded horizontally. Shortly after reopening the mine the present company came upon the footwall or "western" reef—which had been worked to some extent near the surface—in the lower workings to the north of the shaft. The two reefs have come together, and occur in the same formation. The footwall reef was subsequently proved by means of crosscuts back from the old levels to underlie most of the worked-out ground on the hanging-wall reef; and, as it turned out to be a highly-payable body of stone at every point where it was met with, and could be conveniently mined, the greater portion of the ore since obtained from this mine has come from the footwall reef. This discovery gave a new impetus to mining on these reefs, which promises well for the future of Ravenswood.

* The Geology and Reefs of the Ravenswood Gold Field.—J.M.M. By Auth.: Brisbane, 1900. (Q.G.S.P. 152.)

The amount of pyritic material in the Ravenswood ores has always been a source of trouble in the extraction of the gold, but the present company has to a great extent obviated the difficulty in Ravenswood mining by postponing the amalgamation of the free gold till the great bulk of the sulphides has been removed by concentration. The ore, after being crushed through moderately coarse screens, with no attempt at amalgamation either in the boxes or on plates, passes directly on to Wilfley concentrating tables, and three products are obtained. The gold and galena, being the heaviest, pass over the end of the table at a higher level than the other products, and are collected together. The galena shows as a black streak running diagonally across the table above the lighter sulphides, and in the case of rich ore a fine line of free gold can be seen immediately above it. The galena and free gold are ground in Berdan pans with mercury. The remaining sulphurets, consisting of iron pyrites and zincblende, with some copper pyrites, pass over the corner of the table, and are bagged and shipped to smelting works. The sands are stacked for subsequent treatment. The following are the returns from the Sunset Reef since the new company started crushing in January, 1900:—

RETURN OF SUNSET STONE CRUSHED SINCE JANUARY, 1900.

Year.	Stone Crushed.	Concentrates.	Yield from Amalgam.	Yield from Concentrates.	Total.
	Tons.	Tons.	Oz. dwt. gr.	Oz. dwt. gr.	Oz. dwt. gr.
1900	2,390	Not given	...	....	2,317 11 2
1901	3,774	676	6,729 19 0	2,789 6 0	9,519 5 0
1902	11,250	2,066	21,977 16 0	7,338 0 0	29,315 16 0
Total ...	17,414	2,742	28,707 15 0	10,124 6 0	41,142 12 2

These returns show that during 1901 the Sunset stone carried an average of 17.9 per cent. of sulphurets other than galena, and in 1902 an average of 18.3 per cent.; while the amount of gold extracted from the concentrates was, in 1901, only 29.2 per cent. of the total gold obtained from the stone, and in 1902 only 25 per cent.

The above figures show what a high percentage of minerals the Sunset stone carries, and sufficiently explain its refractoriness to ordinary battery treatment. The adoption of a process of concentration before attempting to amalgamate has apparently solved the problem of the profitable treatment of these ores, and seems likely to be applicable to many other localities in Queensland where heavy sulphide ores are found; especially where such are being brought into closer communication with smelting works by the extension of railway systems. This is the first case in which it has been tried in Queensland.

The above figures give an average of 2 oz. 7 dwt. 4 gr. of gold per ton of stone from the 17,414 tons raised to the end of 1902, showing that the values obtained from the footwall reef stone by the new method of treatment compare very favourably with those formerly obtained from the hanging-wall reef.

The "country rock" of the town of Ravenswood is a normal biotite granite, which is generally altered for a considerable width on either side of the reef,

and this "formation," which often shows traces of considerable movement, shades off more or less gradually into the unaltered country rock; there are, however, well-defined and regular walls on both sides of the reefs, and they show every indication of being true fissures.

The Sunset Mine was formerly worked from a vertical shaft 109 feet deep, and an underlie from there down, and the present company have carried the underlie up to the surface, and work direct from there. This underlie, which follows the hanging-wall reef, has a dip of about 54 degrees. Further north, however, the dip of the reef is much steeper, so that in the lower workings it runs into the footwall reef, and the two occur together in the same formation over a considerable area. In the No. 4 level, about 140 feet north of the underlie, the present company, in driving on the hanging-wall reef, met the footwall reef coming in from the south. As this reef was opened out on, it proved to be a highly-payable body of stone, and crosscuts were put in at the No. 2A, No. 3, and No. 4 levels, at distances of 80 feet, 108 feet, and 4 feet south of the shaft. The footwall reef was met with at distances of 80 feet, 130 feet, and 88 feet respectively, and was driven on in either direction from all three levels. The reef here averages from two feet to two feet six inches, and a considerable body of stone has since been stoped out, as is shown shaded vertically on the plan. As the reef was worked up from the highest level it became much smaller, till, in the topmost workings, the average is about one foot thick. The stoping of this stone has kept the battery going for the last two years.

In the No. 2A level on the footwall reef (141 feet V.D.) the Buck Reef was met with at a distance of 208 feet south of the underlie shaft, and passed through in about 208 feet. The Sunset Reef is here seen to pass right through the Buck Reef, but as it does so it pinches from about eighteen inches to a thin vein of four or five inches. On the other side of the Buck it resumes its normal size. According to Mr. Maclaren (*ibid.*, p. 8), the same relationship is found between the Buck Reef and the Grant Reef in the lower workings on the latter, and his conclusion that the Buck Reef belongs to a more ancient system than the majority of the reefs on Ravenswood thus receives corroboration from the workings on the Sunset. Since the writer's visit, the No. 2A level on the Sunset footwall reef has been driven south a distance of 160 feet beyond the Buck Reef.

The General Grant Reef strikes at an angle of about 35 degrees with the strike of the Sunset Reef, and dips to east at a fairly constant angle of about 45 degrees. South, it has been worked down to the 400 feet vertical, and in all the levels the "Buck Reef" was met at about 80 feet or 100 feet south of the shaft; but driving was discontinued on account of the thinning of the reef. In the No. 3 level, however, the Buck Reef was penetrated; but no stoping of ore appears to have been done beyond it. In all the levels going north, however, fair stone was met with at about 160 feet from the shaft. The present company, shortly after opening up the mine, picked up a fine 3-feet reef of heavily mineralised stone in the No. 4 level, at about 300 feet north of the shaft; and they have stoped out a considerable body of stone from between the No. 4 and No. 5 levels, at about 450 feet from the shaft. The plan shows the area stoped out in these new workings. The Warden's books show a return of 13,311 tons of stone taken from this mine from the first period of its working in 1870 till April, 1900, and the yield of gold from this stone is given as 23,651 oz. 12 dwt., or an average of 1 oz. 15 dwt. per ton. The stone is similar to that

found in the Sunset Reef, and the present company treat the two together, so that since the beginning of 1903, when crushing of ore from the Grant was resumed, the returns from the two mines cannot be kept separate.

The success met with by the New Ravenswood Company in opening up these two mines has led to their being blocked off on the east by the Ravenswood Deep Mines, Limited, and on the south by the Grant and Sunset Extended; both these companies having begun sinking vertical shafts to intersect the two reefs. The Ravenswood Deep Mines shaft, the position of which is shown on the plan, should strike the Sunset Reef at about 1,200 feet from the surface, if the reef keeps to the same dip at greater depths that it has in the present workings north of the shaft. On similar conditions, the Grant Reef may be expected to be struck in about 400 feet. The Grant and Sunset Extended shaft should meet the two reefs somewhere about their point of junction to the south, at a depth of about 500 feet. The present hopes of the field are centred in these two shafts, and the prospects of their finding payable stone are very considerable.

The Shelmalier Reef.—This reef is also being prospected by the New Ravenswood Company. The reef strikes north and south, and the old surface workings can be traced for a distance of half-a-mile. The position of the reef is not shown on the plan, but it is almost immediately north of the London lease. From 1870 to 1895, 2,615 tons 11 cwt. of stone were obtained from this reef, and yielded 3,748 oz. 15 dwt. of gold, according to the records in the Warden's books. From 1898 to 1900, 342 tons 4 cwt. 15 lb. of stone were obtained for a return of 239 oz. 4 dwt. 20 gr. of gold. The present company have started work on the old P.C. ground, where a vertical shaft meets the reef at a depth of seventy-seven feet. The reef is here dipping at from 60 degrees to 70 degrees, and in the direction E. 10 degrees S. The best stone has been obtained south of the shaft, where the reef is thrown down to the south by two parallel faults succeeding each other at distances of seventy feet and one hundred feet from the shaft. These faults were also met with in the lower levels, from the underlie at the bottom of the straight shaft, and at increasing distances from it; but the throw of the fault is considerably less as the shaft is descended. The present company have opened up the reef between the two faults in the No. 1 and No. 2 levels, and also to the south of the second fault where the reef averages about one foot in thickness.

III.—THE REEFS AT BROOKVILLE (OR DONNYBROOK).

The reefs in this neighbourhood occur both in granite and in altered sedimentary rocks—quartzites, greywackes, slates, and schists. They lie, in fact, along the junction line between the large area of these sedimentary rocks shown on Mr. Maclaren's map of the field and the mass of plutonic granite which has intruded them, and to the movement and crushing caused by which the alteration and upheaval of the sedimentary beds is no doubt due. The two reefs that have yielded the greatest amount of gold both lie in the sedimentary strata, but in close proximity to the granite, from which their mineral wealth has probably been derived. They follow the bedding planes of the strata in which they lie, and are thus bedded reefs as distinct from the remaining reefs of the field, which all occupy fissures in the granite itself. The quartz of these two reefs is comparatively lightly mineralised, the gold being free and coarse, and easily amalgamable. It thus contrasts strongly with the majority of the reefs of the Ravenswood field, which are almost without exception heavily mineralised and very refractory to battery amalgamation.

The accompanying map of the field shows the work that has been done on these two reefs, and their relative positions and inclinations. It will be seen that the granite, in intruding the sedimentary beds, has thrown them at diametrically opposite angles of bearing, causing the Erin's Hope beds to lie with a steep dip to the north and the Donnybrook beds with a gentle inclination to the east. The Donnybrook Reef has also been intruded by a bar of granite from the main mass, which has cut off the reef completely to the north of the Donnybrook Blocks workings; and again to the south in the P.C. underlie, by a second bar from the main mass, which is found in all the lower workings in that claim.

The Donnybrook Reef.—The work done on this reef is thus confined so far to the area between these two intrusions. North of the Donnybrook Blocks workings the chance of tracing the extension of the reef does not seem very hopeful. At first sight, it would seem as if the Erin's Hope Reef were the continuation in this direction, the line of strike being twisted by the intrusion of the granite; but the entirely different character of the two reefs, and of the beds in which they lie, is against such a supposition.

South of the granite bar in the P.C. workings the greywackes and quartzites in which the reef is found have been again met with at the bottom of the underlie, but the reef has been shifted out of position by the intrusion of the granite bar. These beds dip at about 45 degrees to the south-west, which indicates that they have been thrown down to the south. In order, therefore, to again pick up the reef south of the granite bar, it will be advisable to sink a monkey-shaft at some point well clear of the granite bar.

The vertical shaft in the Blocks Mine met a floor of normal hornblende granite twenty-four feet below the reef. The beds in which the reef lies have a rough but distinct stratification parallel to the dip of the reef, but otherwise show no trace of their sedimentary origin. They have been so completly altered in but distinct stratification parallel to the dip of the reef, but otherwise show no trace of their sedimentary origin. They have been so completely altered in texture and mineralogical composition, probably by the pressure to which they have been subjected by the intrusion of the granite, as to resemble more a diorite than a sedimentary rock in most hard specimens. They show a granular mixture of hornblende and felspar grains in the coarser specimens, but neither of these minerals show well-defined idiomorphic bounding planes. Microscopic sections show a mass hypidiomorphic felspar surrounding the hornblendes, which themselves show few crystal boundaries. Both minerals are very much decomposed, the felspar being clouded with kaolin and fluked with quartz grains, while the hornblende shows abundant chlorite and calcite decomposition products. The rock is thus mineralogically a diorite, but its structure and occurrence in the field point to its having been derived from the complete metamorphism of a sedimentary rock. The walls of the reef are well-defined and regular, and serve to define one of the bedding planes of these beds, which has afforded facilities for the deposition of gold-bearing quartz.

Faulting of the Donnybrook Reef.—In the Donnybrook Blocks Mine, as the underlie was continued down from the bottom of the vertical shaft, the reef was completely cut off by a fault crossing the underlie at a point about fifty-six feet in a horizontal line east of the shaft, and at the angle shown on the plan. The same fault was met with in all the levels going north, at increasing distances from the underlie. As the fault is approached the reef and the accompanying beds are bent rapidly over to a steeper dip, and the quartz is finally cut off sharply against a wall of almost vertically standing beds of quartzite and grey-

wacke. In several places in the workings, where the fault has been well-exposed, detached fragments of quartz are found in the fissure below the level of the reef, having evidently been dragged down by the movement, and torn off the reef as it was broken across. As these indications led to the view that the fault was a downthrow to the east, the underlie was continued for another forty feet at a slightly steeper grade, and was then rapidly steepened to a dip of 65 degrees from the horizontal. Not meeting with the reef, and an idea gaining ground that the fault might be an upthrow, a crosscut was put into the hanging-wall to a distance from the fault of 232 feet, before being abandoned without success. A second crosscut was then put into the footwall and met the fault, with the solid granite lying against it on the western side. This last fact proved conclusively that the fault was a downthrow, and accordingly the underlie was continued till it had reached a depth of 203 feet vertically below the point at which the fault was first met with; and it was being still sunk when the writer visited the mine in May, 1902. On his advice, this sinking was given up, and a monkey-shaft put down from the crosscut between the No. 2 and No. 3 levels. The latter level had passed through the fault, but instead of penetrating vertically standing beds on the other side, as in the case of the underlie, it met with beds lying at practically the same angle as those above the fault. It was consequently concluded that the throw of the fault in this direction was not nearly so great as further south, and that there was a better chance of finding the reef within a reasonable distance. The monkey-shaft met the reef in eleven feet, and levels were immediately put in north and south, and a winze sunk to the dip. Unfortunately, however, for the further prospects of the mine below the fault, the reef here rapidly thinned out in all directions, and after 208 tons of stone had been raised it had to be abandoned. The yield of gold from this stone was 601 oz. 18 dwt., so that the quality was well-maintained. The reef has, however, apparently been so broken up by the faulting as to be unprofitable on the downthrow side. The steep angle at which the beds lie in the hanging-wall crosscut and at the bottom of the underlie imply a degree of squeezing of the bed which did not promise well for the continuance of the reef south of the fault, and the work lately done on the reef has shown it to be too patchy in occurrence to be profitable.

The Erin's Hope Reef has been worked mainly in the P.C. ground, where a shoot of good stone some 160 feet in width has been worked down to a depth of 290 feet. The dip of the reef is about 57 degrees. The quartz occurs along a bed of talcose schist, lying between two beds of quartzite, and thus constituting a "formation" for the reef between two well-defined walls. These walls lie, as a rule, from three feet to four feet apart. The quartz, which runs up to two feet in thickness, occurs now on the footwall and again on the hanging-wall of this "formation," which, being very soft, is very easily mined. Neither the No. 1 East nor the No. 1 West claims have struck quartz, though the former has driven on the same formation as that found in the P.C. claim for some 200 feet to the east of the P.C. workings. A crosscut put in towards the footwall from the No. 1 East 190-feet level struck the granite in twenty-eight feet from the line of reef. This reef has crushed, from 1900 up to the end of 1902, 1,709 tons of stone for a return of 5,318 oz. 7 dwt. 14 gr. of gold.

IV.—THE KIRK DIGGINGS.

A stimulus was given to mining in this locality during the latter part of 1901, by the formation of two Charters Towers syndicates to work the Morning Star and Himalaya Reefs; which had been practically abandoned since 1889.

The Kirk Reefs lie about sixteen miles due west of Ravenswood, between the Kirk River and Pandanus Creek. The shortest track to the railway line is to the Kirk Siding, on the Ravenswood branch line, some eight miles off. Six main lines of reef, all, roughly speaking, parallel to each other, have been worked along a line of country stretching in an easterly and westerly direction for about a mile and a-half. This belt of reef-bearing country runs along the junction lines between an area of grey biotite granite on the south and another of red granite porphyry on the north. The presence of the latter is marked by rough stony hills, which stand out in contrast to the level country occupied by the softer grey granite. The four most persistent lines of reef—the Morning Star, Lady Margaret, Himalaya, and Lady Jane, as well as the Sisters line—have been traced right across the boundary between the two formations, and have been worked in both; while the remaining reefs are found in the granite porphyry. The majority of the reefs, especially those in the biotite granite country, are accompanied by dykes of intrusive diorite; occurring in the formation alongside of the reefs.

At the time of the writer's visit, the Sisters Mine was the only one that had been working for any length of time previously, while the Morning Star and Himalaya were the only two others to which steam winding-gear had been applied.

The Morning Star Reef had formerly been worked from several shafts, which have fallen into disrepair. The following records of former crushings are given in the Warden's books at Ravenswood:—

—	Stone Crushed.	Yield of Gold.	
	Tons.	Oz.	dwt.
1874 and 1875	1,154	2,160	5
1878	132	104	0
1889	76	124	18
Total	1,362	2,389	3

The main lode strikes W. 35 degrees N., and dips steeply to the east. The main shaft is 290 feet deep; and a second shaft, 120 feet south, is 160 feet deep. Practically, all the ground between these two shafts to the 160-feet level had been stoped out. As the formation was of considerable width, and the "mullock" filled in was badly secured, a great portion of these workings have fallen in, leaving great open spaces, crossed by broken timber and badly supported ground. The width of the formation taken out was in places as much as twelve feet and fourteen feet. The present company had, at the time of my visit, connected the two shafts with a level at the 160 feet, and bailed out the main shaft, which they had put into working order, with a complete winding-plant.

At the bottom of the shaft (290 feet) the reef had formerly been driven on for eighty feet to the south, and stoped out for about nine feet above the roof of the level. It showed from six inches to one foot of mineralised stone. The walls of the reef are diorite, and a second body of quartz, about two feet in thickness, and running off in a south-westerly direction, is seen on the footwall,

near the shaft. In a short drive along the reef to the north the reef had pinched out, and had not been further prospected. Thirty-five feet above is a second drive, which goes in about thirty feet, and shows from nine inches to one foot of stone. The three crushings of 76 tons taken out in 1889 apparently came from these two drives, and from the last 100 feet or so of the shaft, and show an average of 1 oz. 12 dwt. 19 gr. of gold per ton. None of the levels have been carried more than a few feet north of the shaft, the reef apparently being poor in that direction.

On the surface, the granite porphyry first comes in near the main shaft, and the reef has been prospected for by a third shaft some 250 feet further north; this was inaccessible, but some stone was to be seen on the surface. South of the main shaft the reef is in grey granite, and most of the work seems to have been done in this rock, as the remains of other shallow shafts and open cuts extend for a distance of 250 feet. A second parallel reef occurs about a chain further to the east, and shows the remains of two old shafts. These reefs, and the diorite with which they are associated, apparently fill fissures which run at right angles to the junction plane of the two masses of granite, and which have no doubt been caused by the expansion and contraction of two masses of rock brought into contact at different temperatures.

The Himalaya Reef has been worked in the porphyritic granite for some 200 yards along its outcrop by numerous shallow shafts, which for the most part disclose a white, poor-looking stone. The present company sunk one of these shafts to a depth of 170 feet, and drove along the reef at that level for a distance of eighty feet south and one hundred feet north. The drives show a strong, permanent-looking reef throughout, averaging between two feet and three feet of heavily-mineralised stone. The 80-feet level of the older workings, going south for seventy-five feet along the lode, had been cleaned out, and a winze sunk to the bottom level. About 140 tons of stone had been raised. Assays from this stone had given results from 5 dwt. to 1 oz. per ton. A crushing of 105 tons of this stone, since put through, gave a return of only 26 oz. 10 dwt. of gold. The mine has since been abandoned, as even with the large body of stone obtainable this result was deemed too low to constitute a payable body.

The Lady Jane Reef is on the same line as the Himalaya, in the biotite granite to the south. It was being opened up by a shaft 116 feet deep, which exposed a reef of almost solid pyritic ore running up to one foot in thickness. A few tons of ore had been raised for shipment to smelting works.

The Sisters Reef.—This reef is the most westerly on the field, and has been worked more or less continuously for some years. The reef is almost vertical, with a slight hade to the west, and the bottom level is 235 feet deep. The shoot of good stone, some 260 feet long, lies for the most part to the south of the shaft, as the drives going north at the 120-feet and the 180-feet levels met with poor stone at about sixty feet from the shaft; and the former on being continued to 130 feet met a fault, which has apparently thrown the reef to the east. The reef occurs associated with a diorite formation between red granite porphyry walls, and is very irregular at times, pinching out entirely and then making into large bodies of quartz. At the 235-feet level in the end of the drive going south, and at 180 feet from the shaft, the reef showed two feet in thickness against a hanging-wall of granite. The remainder of the face of the drive was diorite, twelve feet across, with several thin non-persistent veins of

quartz near the footwall. The stone is heavily mineralised, and is being crushed at the Rochford Mill, some miles distant. I was unable to obtain any record of the crushings.

The Kirk Brilliant and Crescent Claims are on the same line of reef, a little to the north and east of the Sisters, and in the granite porphyry. The Kirk Brilliant was not being worked, but the Crescent Claim had a vertical shaft on the reef 125 feet deep, with a drive forty feet south and another twenty-five feet north. The reef is from six inches to ten inches in width, the stone being very heavily mineralised with galena and iron pyrites. The greater portion of this, after dressing out the lighter stone, was being bagged for shipment to Aldershot; the stone being too heavy with mineral for battery treatment.

[No. 182 of the Queensland Geological Survey Publications.]

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND.

REFERENCE

Outcrop of Reefs

Upper Workings on Reefs

Lower Workings on Reefs

PLAN OF RAVENSWOOD TOWNSHIP

SHEWING WORKINGS ON GRANT & SUNSET MINES REDUCED FROM MINE PLANS

To Accompany Report

ON RECENT MINING DEVELOPMENTS

BY

WALTER E. CAMERON

Assistant Govt Geologist

1903

Scale 4 Chains to an Inch.

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND.

GEOLOGICAL MAP OF BROOKVILLE GOLDFIELD

SHEWING WORKINGS ON DONNYBROOK & ERIN'S HOPE REEFS

To Accompany Report on the RAVENSWOOD GOLDFIELD.

BY

WALTER E CAMERON

Assistant Govt Geologist 1903

Scale 4 Chains to an Inch

4 3 2 1 0 1 2 3 4

Erin's Hope Gully

RAVENSWOOD RD.

ERIN'S HOPE P.C

ERIN'S HOPE EAST

ERIN'S HOPE WEST

Shaft

MAIN ST.

Erin's Hope Reef

Contour of Granite 100' V.D.

Contour of Granite 190' V.D.

IV 290' V.D.

III 204' V.D.

II

I

60°

UNDERLIE

X CUT TO GRANITE

Drive on Formation No Stone

150' V.D.

Monkey Shaft 11 ft to Reef

WINZE

X CUT A

Donnybrook Blocks Main Shaft 190' to Reef

277 V.D.

X CUT. D

70°

Quartzites

Quartzites & Greywackes

60°

Donnybrook Extended Shaft 830' vertical

DONNYBROOK EXTENDED

Q

Donnybrook Reef

Old Surface Workings

UNDERLIE SHAFT

Granite Dyke in Workings

FAULT

22°

45°

Old Underlie Shaft

DONNYBROOK P.C

DONNYBROOK BLOCKS LEASES

G.M.L 394

WILSON ST.

BARTON ST.

CUSACK ST.

Tucker Gully

G

Hope Reef

Nil Desperandum Reef

G. M. L 460

G. M. L 413

G. M. L 412

Columbia Reef

UNDERLIE

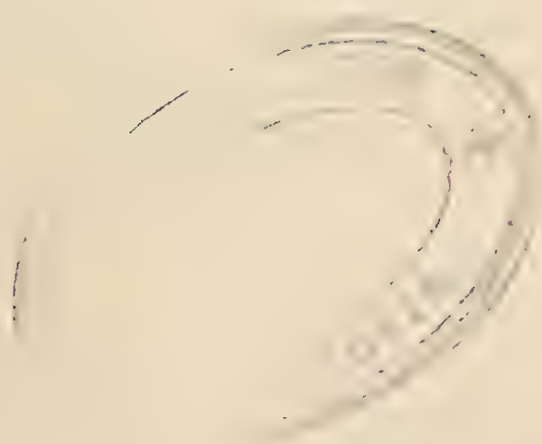
Shaft 145 Ft Vertical

Perseverance Reef

N

INDEX

Granite	G
Quartzites Slates & Schists (*of Undetermined Age*)	Q
Stoped ground shaded	
Dip of Strata	→
Where steep	↘



VICTORIA.

Queensland.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY REPORT,
No. 184.

REPORT

ON

GOLD WORKINGS IN THE PERRY SCRUB,

BURNETT DISTRICT.

By LIONEL C. BALL, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

BRISBANE:
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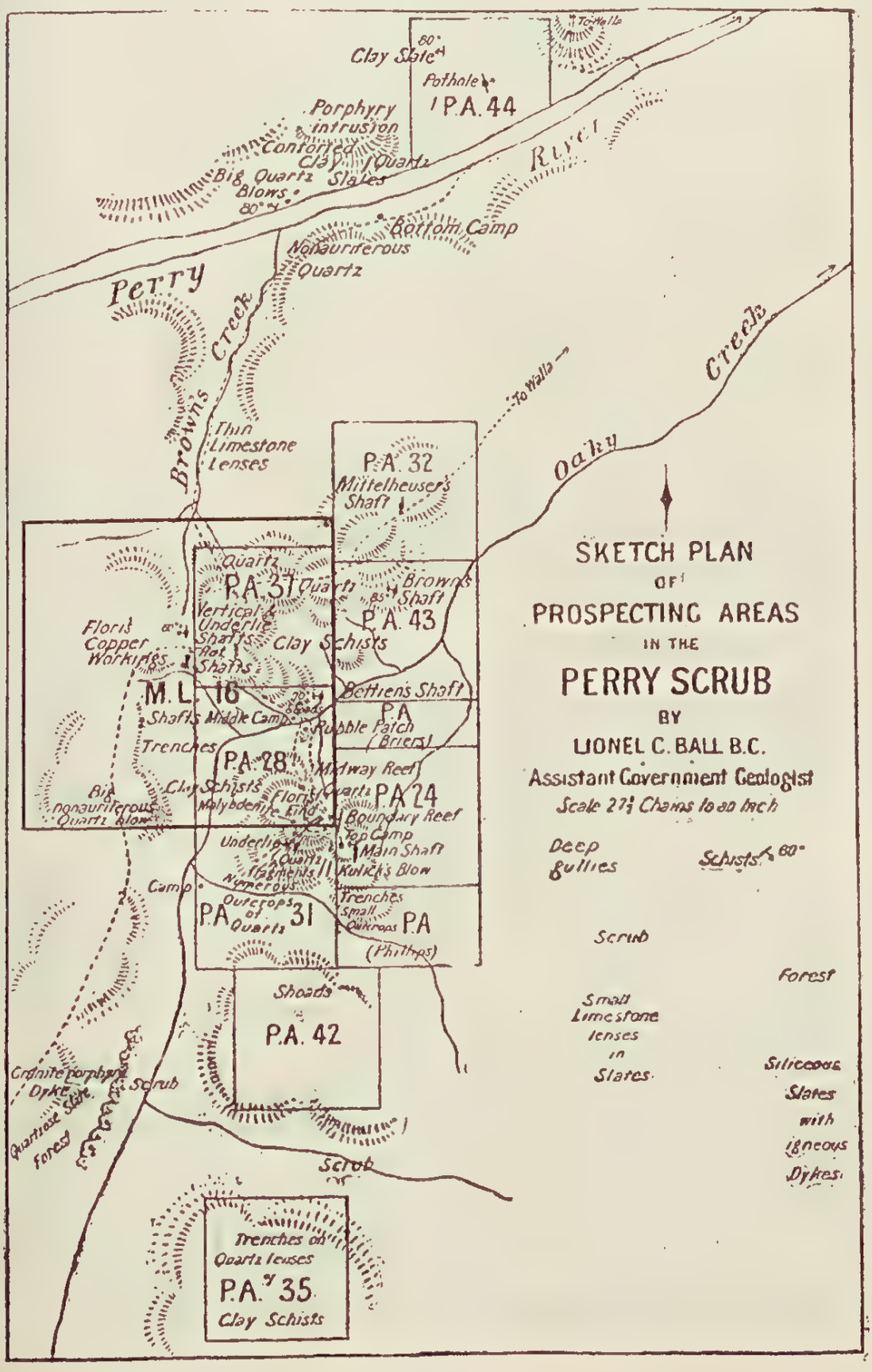
REPORT ON GOLD WORKINGS IN THE PERRY SCRUB, BURNETT DISTRICT.

1. LOCALITY.

The Perry (Good-night or Tenningering) Scrub extends in the form of a narrow belt from Saint Agnes Creek, on the north, to the Burnett River west of Paradise, on the south, crossing the Perry River about 6 miles above its junction with the Burnett. The workings are in about the centre of the scrub, and are all within 2 miles of the Perry. (*See* plan.) The distance by road



to Gin Gin is 18 miles, to Childers 29 miles, and to Mount Perry about 30 miles. The last, besides being the longest, is by far the roughest, and is very seldom used. Timber-getters' tracks are followed from the scrub to Walla on the Burnett, where the Gin Gin and Childers roads diverge; thence the road from Walla to Gin Gin is mostly flat and in very good condition, while that to Childers is both hilly and sandy, so that Gin Gin is the only practicable outlet for the field.

2. TOPOGRAPHY.

The scrub country is broken, owing to numerous long and steep ridges; but the surface in the neighbourhood shows no great relief, the greatest difference in elevation between creeks and hilltops being less than 100 feet. The Burnett River and its tributaries, Saint Agnes Creek and the Perry River, flowing in from the west, form its greatest features. In ordinary times, the Burnett, a swiftly-flowing stream, and the Perry, usually referred to in the district as the Creek, had numerous large waterholes, even in the last drought. Oaky Creek, opening into the Perry, drains the country about the workings, and, though it runs dry a very short time after rain, it would be possible to conserve a supply of water at many places by dams across it.

The scrub consists of a thick growth of moisture-loving plants, such as Hoop Pine, Lignum vitæ, Flindersia, &c., with shrubs and vines too numerous to mention. Its growth is due to the fact of the schist forming a fairly good soil, with a great capacity for the retention of moisture. At various times during the last twenty years it has been exploited for pine, and has in consequence been well opened up with tracks. Prospectors thus have no difficulty in traversing it.

3. DISCOVERY.

It is said that gold was reported three years ago by Mr. P. Flori, a timber-getter, who also found copper and took up a mineral lease (No. 16). The announcement of the discovery of gold by Mr. J. Jocumsen in October, 1902, caused a small rush, but there were never more than a score of men on the field at one time. Fourteen prospecting areas, on most of which gold has been found, have been pegged out, several of them having been held and abandoned by more than one party.

The want of faith of miners in the prospects of the field, as shown by their departure, is caused—firstly, by the absence of gold in the creek alluvial and in the detrital soil on the hills (causing a lack of capital to work the reefs); secondly, by the poor "prospects" obtained as a rule on crushing the stone; thirdly, by the patchy occurrence of the gold; and, fourthly, by the apparent non-permanence of the reefs.

4. GENERAL GEOLOGY.

(*a.*) The country rock of the whole field thus far tested is a clay schist, with a general strike of about north and south (though exceptionally and locally, as at Flori's Find, almost at right angles to this) and generally dipping at a high angle owing to extensive folding. A practically continuous belt, less than a mile in width, of this rock extends from Monduran on the north to Chowey on the south, a distance of 40 miles.

Comparatively unaltered slates are found just outside the scrub half a mile to the east of the workings. They strike north-east, and dip steeply to south-east. Unlike the schists, they have been intruded by dyke rocks and may be younger than the schists.

(*b.*) Throughout the schists are abundant lenticular quartz veins and veinlets running parallel with the bedding. These vary in thickness from a fraction of an inch up to 10 feet, but seldom extend for more than a chain. In many parts traces of gold can be found in this quartz, but in the Perry Scrub the amounts were large enough to encourage the prospectors to peg out claims. Gold-bearing quartz is reported from the southern extension of the same belt also.

The schists have most probably originally been ocean sediments, and altered by pressure and heat from shale and slate into schist; most of the quartz separating out during the latter processes of metamorphism to form what are known as segregated or segregation lenses. It must be mentioned, in parenthesis, that doubt has lately been thrown on the segregation theory,* some believing that the bodies represent original fissure-veins broken up and squeezed into isolated lenses by earth pressure. If such were the origin, one would expect to be able to always pick the quartz up again on further driving and sinking.

The reefs are characterised by the massive character of the quartz and its general barrenness of metallic minerals, by the shortness of the outcrops and their relative great width, and by their lying with their longer axes parallel to the foliation of the country rock.

Such segregation deposits are typically not permanent in depth, and have usually no greater vertical than longitudinal extent. Pyrite was observed in small quantities in a few of the workings, and in one outcrop small scales and bunches of molybdenite were found. The gold seldom or never occurs throughout the deposits, being either in shoots, in bunches, or else in zones on one of the walls, so that, though the reef may be many feet wide, only a few inches are auriferous.

The quartz veins in the Brisbane schists belong to this category, but differ from those in the Perry Scrub in being much thinner, though somewhat more permanent and in greater numbers. Reports of the finding of colours and isolated grains of gold from these have often been published.

(*c.*) Limestone occurs in the schist in relatively small amounts. it and quartz in any part of the belt being in inverse proportion. It occurs in small quantities north and south-east of the main workings, and other larger deposits occur farther north in the Gin Gin district and south near Tenningering Station. The origin of part of the limestone has probably been similar to that of the quartz, for no trace of fossils could be found at the localities examined. (The Tenningering limestones were not examined.)

(*d.*) Granite occurs on the left side of the Perry River, about a mile west of the workings, but no evidence was obtained as to whether it is intrusive or not. The auriferous character of the quartz in this locality may have been caused by its intrusion.

5. WORKINGS.

At the time of my visit, 14 prospecting areas had been pegged out (*see* plan)—one on the north side of the Perry River, the others across the river, east and south of an abandoned mineral lease (No. 16).

The south-eastern corner of the lease, which is in about the centre of the workings, was taken as datum point; it lies a mile south of the Perry River and about 3½ miles west of the Burnett.

Three of the areas appear to have been abandoned, and a fourth has only just been pegged out. There were only 8 men on the field, and most work was being done on prospecting areas 24, 31, and 43.

(*a*) Prospecting Area No. 24 (known as the P.C.).

Area, 400 by 400 yards. Adjoins M.L. 16 at the south-eastern corner.

Two reefs have been prospected—one 2 chains south-east of the corner peg of M.L. 16, the other within 2 yards of the western boundary of the area. On the former, which strikes about north and south and is nearly vertical, two shafts have been sunk, 24 feet apart, the northern of which is 40 feet deep. It was accessible to 26 feet only, at which level is a drive connecting with the bottom of the southern shaft. Above the level the reef has been stoped out. The ground has been trenched for 1½ chains south of main shaft and also to the north, but nothing beyond thin leaders has been discovered.

---

* Kemp's "Ore Deposits of the United States and Canada."

The prospectors informed me that the width of quartz stoped varied up to 18 inches, and that at 40 feet depth the reef gave way to "formation" carrying a little gold. The reef cut out within a few feet of the shaft on the northern end, but was followed to the south for 35 feet before pinching. The only quartz (bunches up to 9 inches across and 1 foot in length) now to be seen in the workings is underfoot in the drive between the shafts.

The gold is said to have been confined to no particular part of the quartz—a most unusual thing in this locality. The returns from the quartz raised are:—

	Tons.		Oz.	dwt.	gr.
February, 1903	5½	for	7	14	12
April, 1903	10	„	15	10	0
June, 1903	6	„	12	0	18
	21½	„	35	5	6

An average of over 1½ oz. per ton.

The country on the west is smoothly foliated clay schist, that on the east being rather more contorted and somewhat sandier.

There is no promise of the same reef being found on further sinking, though other independent lenses may, of course, be struck.

The western or boundary reef runs parallel to the eastern boundary of M.L. 16, and dips near the surface at an angle of 70 degrees to the west. It has been trenched for 100 yards to a depth of 10 feet, and potholes have been opened and specimens picked up for over a distance of 3 chains. Traces of galena and pyrite have been found in the quartz here.

Below is a sketch of the exposure in the centre of the trench, looking south—

Fig. 1.

SEGREGATION VEINS.

Scale, $\frac{1}{20}$th.

A sample was taken from the few tons of ore at grass. Crushed and washed at the office, it gave a small prospect of very fine gold. Assayed by the Government Analyst, it yielded:

Gold = 3 dwt. 19 gr.; silver = 1 dwt. per ton.

In January last 3 tons of stone from this trench and from "shoads" to the south yielded 16 dwt. per ton. The country rock is clay slate showing much folding and puckering. Stringers of quartz in the hanging-wall country adjacent to the reef carry gold in places.

About 3 chains east of the main line auriferous specimens have been found and traced for 8 chains to the north, where is an opening on a 12 to 18 inch reef carrying pyrite, but no free gold. Colours of gold have also been found in the centre of the northern boundary.

(*b*) Prospecting Area 28.

Area, 400 by 400 yards. Situated in south-eastern corner of M.L. 16.

The main workings are on the hilltop, in the south-eastern corner, where there is a large outcrop known as Flori's Find, caused by the development of four parallel quartz bodies, within a distance of a few yards of one another. A trench (8 feet in greatest depth) has been cut across them from the west-north-west, and shows that they strike with the clay-schist country (here about north-east), and dip 1 in 10 to the north-west. The western reef is 6 feet thick. Near the trench it stands 2 feet above the ground, and it can be traced by fragments on the surface for 2 chains to the north-east and for possibly 4 chains to the west-south-west. The thickness decreases rapidly southwards; but the number of parallel veinlets increases at the same time. Fragments of quartz are strewn over the ground for over 5 chains to the south-west, but they probably form separate bunches in the schists.

The quartz is massive and generally white, but some of it weathers pink and has ironstained cracks throughout it. The best gold is said to have been found in the central part of the reef. A sample was taken from the trench and for 2 chains to the south. The result of analysis is:

Gold = 9 dwt. 9 gr.; silver = 5 dwt. 8 gr. per ton.

Another sample from the cut only gave:

Gold = trace; silver = trace.

The next blow to the east is separated from the above by 25 feet of schists (quartz-veined in part). It is 2 feet thick, and can be traced by fragments on the surface for half a chain to the south. A sample from the trench yielded:

Gold = 4 dwt.; silver = 2 dwt. 16 gr. per ton.

Then, 3 feet beyond this is another reef 18 inches thick, a sample from which yielded:

Gold = 1 dwt. 8 gr.; silver = 1 dwt. 8 gr. per ton.

The prospectors refer to the two last-described reefs as the "eastern," and have found them to carry much better gold than the big western reef. No work has been done on them outside the trench, and it is doubtful if they continue more than a few feet.

A shallow pothole has been sunk on a fourth reef (known as the "iron lode"), about 10 feet east of the above. The quartz is strongly stained with oxide of iron, and has yielded the prospectors the best prospects of all. The reef—2 feet thick—has been exposed by a trench for several feet, and a pothole 2 yards to the south, sunk on loose blocks, cut the reef at 9 feet depth, but it was then abandoned.

A parcel of 10 tons of stone was being sent away for a trial crushing at the time of my visit, but the returns have not yet been received.

Molybdenite occurs to the extent of, perhaps, one-half of 1 per cent. in surface quartz, containing gold and pyrite, a few yards to the south of the big outcrop. The spangles are generally less than $\frac{1}{8}$-inch in diameter. On account of the small amount it is not very promising, but, as molybdenite sometimes increases in depth, it would be worth prospecting.

There are numerous outcrops on this area. The first, north of Flori's Find, is known as the Midway Reef. Here quartz fragments occur, distributed over an area 2 chains across, and traceable for 2 chains further to the north. Trenches and potholes about 1 chain apart only expose quartz lenses 6 to 12 inches long, forming a belt 2 to 3 feet wide in the clay schist, here striking north-north-east and almost vertical. Some of the quartz carries coarse pyrite, and the gold—good prospects of which can be washed from parts of the quartz—is said to be very patchy. A sample from the whole of the exposure yields:

Gold = 9 dwt. 23 gr.; silver = 4 dwt. 22 gr. per ton.

The whole surface over an area 3 by 2 chains on the south side of Oaky Creek is covered with white and pinkish quartz fragments, from the more strongly coloured ones of which good prospects of fine reddish gold can be dollied. This quartz has probably been shed by a great number of leaders in the schists. A sample from here yields:

Gold = 1 dwt. 8 gr.; silver = 16 gr. per ton.

Gold-bearing "shoads" are plentiful north of Oaky Creek, in the north-eastern corner of the area, and Bettien's shaft has been sunk 18 feet on a leader 3 inches thick at the surface, but averaging 9 inches below. The strike is a little east of north, and the general dip is the same as the clay-slate country. It cut out on the north end of the shaft. The stone obtained (2½ tons) was mixed for crushing with 5 tons from P.A. 32, so that it is not known what it may have contained.

A sample from the shaft yields:

Gold = 8 dwt.; silver = 2 dwt. per ton.

(*c*) Prospecting Area 31 (Glenister's).

Area, 400 by 400 yards. Adjoins P.A. 28 on the south. Two chains south-west of Flori's Find an underlie has been opened on a 4-inch segregation leader, dipping 70 degrees to the north-west. At the bottom, 27 feet from the surface, the quartz has increased to 2 feet 7 inches in thickness at one end, but at the other it is mixed with country rock (clay slate). The best gold is said to have been on the hanging-wall; 9 tons 5 cwt. of quartz from the shaft yielded at Gympie (without the concentrates):

Gold = 7 dwt.; silver = 1 oz. per ton;

but much higher assays have been obtained. A sample taken from near the bottom of the shaft yielded:

Gold = 3 dwt. 8 gr.; silver = 1 dwt. 8 gr. per ton.

Fifteen yards south-west of the underlie is a windlass-hole 10 feet deep on a segregation quartz zone, 12 to 18 inches wide, the stone from which has assayed up to as high as 2 oz. 18 dwt. per ton. Quartz fragments lie on the surface for 30 yards south of this hole, and some leaders have been trenched several chains to the south-west, where they appear to be very numerous. One chain west of the underlie shaft a trench has been cut across a reef, on the line of strike of the eastern vein on Flori's Find.

Kulick's Blow is near the eastern boundary, 4 chains south of the south-eastern corner of M.L. 16. The quartz in the widest part is 2 feet 6 inches thick, but it quickly tapers, and pinches out within 10 feet both north and south. Ten yards to the north it again comes in, and has been trenched for 1 chain. It is vertical, and the general strike is north by east. The main mass of the quartz is white and hungry-looking, with iron stains only on the larger cracks; but on the eastern side is a laminated coating of iron-stained quartz, with a mammilated surface. The walls are unusually well defined, but the evidence, on the whole, points to its being a segregation vein. A sample from this outcrop and about 3 tons of ore at grass was dollied and washed in the office, but did not yield any gold. The country rock is yellowish-brown clay slate.

The quartz worked on this area probably belongs to different lenses to those on P.A. 28.

(*d*) Prospecting Area 35 (Southern Extended).

Area, 400 by 400 yards. Workings lie about three-quarter mile south of Flori's Find.

Numerous trenches have been made on lenticular bunches of quartz in clay-slates striking north and south and dipping 80 degrees to the west. On the east a trench 15 yards long exposes bunches of quartz up to 18 inches

thick. These are said to have carried gold near the hanging-wall. Two yards west of northern end of this, a separate lens, 18 inches, has been exposed, and 3 yards west of the southern end a line of lenses up to 12 inches thick have been exploited by potholes and trenches. The more auriferous portion of the latter line—a shoot about 1 foot in diameter, which contributed most of the gold to the crushing given below—has been removed. The quartz now remaining in the larger bunches is slightly "mineralised" (pyritous), but does not carry payable gold, though the miners found the schist at the ends of the lenses to sometimes contain a little gold.

A crushing, in May last, of 4 tons of stone from these trenches yielded 4 oz. per ton.

A sample from all the exposures yields:

Gold = 1 dwt. 8 gr.; silver = 2 dwt. per ton.

A surface sample was taken from an outcrop of white quartz on the southern side of Oaky Creek, about half a mile south-south-west of P.A 35. The area covered is 1 chain in length and 20 feet in width, and fragments have been picked up for a quarter of a mile to the south. The sample crushed and dollied yielded only the faintest possible trace of gold.

(*e*) Prospecting Area 43 ("Childers Retreat").

Area, 400 by 400 yards. Adjoins M.L. 16 on the eastern side, and separated by a few chains from P.A. 24.

A shaft in the northern portion of the area was begun on 2 feet of quartz, but below the subsoil two separate leaders were found, decreasing in thickness and at 10 feet depth apparently cutting out.

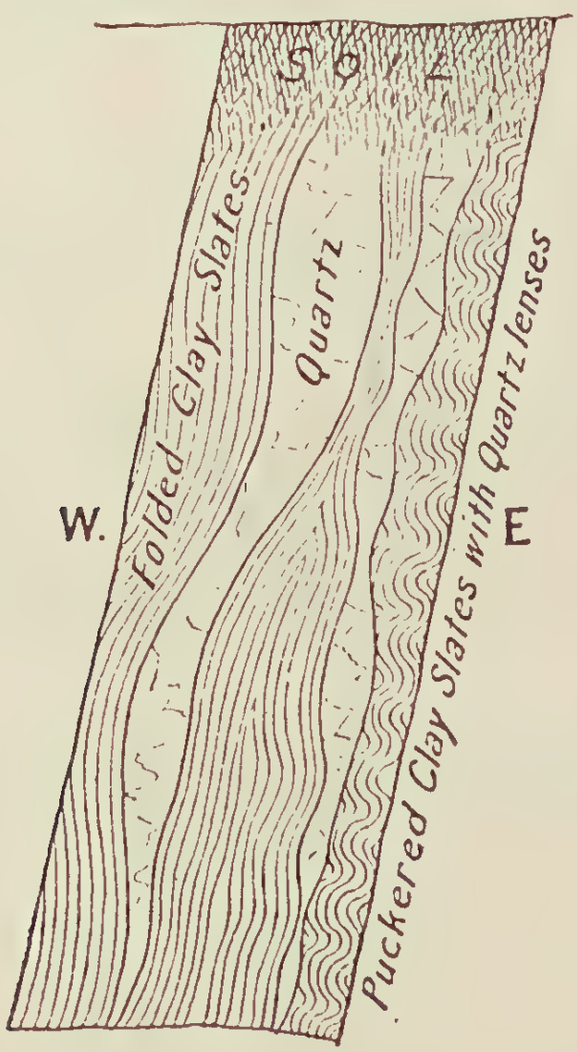


Fig. 2.

Segregation Veins, North End of Shaft.

Scale, 32 feet to an inch.

The strike is N.N.E., and the dip is very steep to the west. The quartz is rather iron-stained, and the darker parts carry pyrites as well as fine gold. A shallow hole 10 yards to the north exposes 6 inches of quartz, and trenches to the south expose only thin leaders. About 5 tons of ore have lately been sent to Aldershot, but returns are not yet available. A sample from the shaft and ore paddock dollied a very fair prospect of gold and assayed:

Gold = 3 dwt. 8 gr.; silver = 1 dwt. 8 gr. per ton.

The clay-schist country on the eastern side of the lode is minutely contorted, but that on the west is broadly folded parallel to the swellings of the quartz; south of the shaft are dark bands strongly impregnated with pyrites.

(*f*) Prospecting Area 32.

Area, 400 by 400 yards. Adjoins P.A. 43 on the north.

The workings are in the centre of the area within a couple of chains of the Walla road. A shaft has been sunk 25 feet on a vertical zone of 6-inch quartz lenses striking north-north-east. Five tons were raised, but were crushed with 2½ tons of stone from P.A. 28, so that the yield of 10 dwt. per ton gives little idea of the contents.

Another outcrop 10 yards south-west of the shaft was opened to a depth of 3 feet. The quartz looks promising, but it occurs in lenses only.

(*g*) Prospecting Area (Phillips).

Adjoins P.A. 24 on the south.

Small outcrops of white quartz about 5 chains south of the P.C. shaft have been found to contain colours in places. Rich shoads were found by prospectors to the east of this, but trenches failed to cut a reef.

(*h*) Prospecting Area (Briers).

Lies between P.A.s 43 and 24.

This has been held by several parties, but they have failed to find any reef, and the ground has been again abandoned.

(*i*) Prospecting Area 42.

Adjoins both P.A. 31 and Phillips' area on the south.

Shoads of cellular iron-stained quartz showing a little free gold and pyrite, especially on laminæ, have been found in two or three places in the northern portion. A sample from a heap of these, crushed and washed in this office, yielded only a trace of gold equivalent to a few grains per ton. No search has yet been made for reefs, and it is not proposed to begin work till a battery has been erected.

(*j*) Prospecting Area 37.

Area, 400 by 400 yards. Adjoins P.A. 28 on the north.

Several chains of trenches have been opened near the southern boundary, but without finding either reefs or leaders. The area appears to have been abandoned.

(*k*) Prospecting Area 44 ("Painkiller").

Lies on the northern side of the Perry River, a little over 1 mile north of the P.C.

In the centre of the area is a pothole on the northern end of a body of quartz, 9 inches in greatest thickness, only one block of which outcropped on the surface. The strike is north by west, and the dip is 85 degrees to the east. The reef is believed to carry gold, except in the milk white portions.

A sample from the ore exposed yields:

Gold = 4 dwt.; silver = 16 gr. per ton.

Other outcrops have been seen to the north, but they have not yet been prospected.

An 18-inch reef is exposed for half a chain in the bed of a creek near the river, 5 chains west of the area. The strike (local) is east-north-east owing to a fold in the contorted clay-slate country. Other reefs outcrop on and near the river bank, about 10 chains above this. At the latter 3 to 4 feet of quartz have been laid bare for a length of 10 feet, the reef apparently dipping 80 degrees to the north-west. A sample from this assayed:

Gold = trace; silver = trace.

Specimens dollied and washed showed only traces of gold.

(*l*) Prospecting Area. (?)

Lies south of P.A. 42. This area has just been pegged out, but no work has yet been done on it.

(*m*) Mineral Lease No. 16.

Area, 160 acres. Position, a little over half a mile south of the Perry River.

The workings are in about the centre of the lease, near the timber road, connecting with Walla, which is now the main track for the ore wagons.

The southern workings lie 1 chain south of the track. The top shaft, sunk at the beginning of the year, is 20 feet deep; the middle, 5 yards to the south-south-west, 30 feet deep; and the third, 10 yards beyond, 35 feet deep (but now open to only 25 feet). These are all inaccessible, owing to absence of ladder and windlass. The middle and southern shafts were connected by a drive which was carried some feet further to the south. In the ends of the lower shafts 2 feet of red gossan, dipping steeply to the west, can be seen with a good footwall. Though there is no defined hanging-wall, there are several inches of decomposed white schist, into which the ore is said to have changed at the bottom of the shaft. The only traces of ore now to be seen on the tips are thin crusts of blue and green carbonates on the schists. Slight traces of copper have been found for half a mile to the south, and a considerable number of trenches have been cut, but without discovering any lodes.

The northern workings are 2 chains north of the track, on a gossan lode dipping, with the drab-coloured clay-slate country, 60 degrees to the west. An underlie shaft has followed the lode to 20 feet depth; then a drive was run 20 feet to the north, and from the end a winze 10 feet deep connects with a vertical shaft. The gossan seems to be on a fissure which is well defined centrally in some places and on the footwall in others, but seems sometimes to die out altogether. Down to the 20-feet level it varies from 9 to 15 inches in thickness, with a 3-inch leader on the hanging-wall, but it then disappears. At a depth of 35 feet the gossan (containing a little copper carbonate) again comes in, and averages 18 inches to the bottom, where there are several irregular chambers up to 15 feet in length, which probably represent bunches of ore removed. A sample of the gossan in the underlie was taken, but it contains only a very small percentage of copper.

The country rock is clay-slate, strongly impregnated with brownish manganese dioxide in the form of dendrites; it appears on the hanging-wall to have been subjected to leaching.

It is rumoured that the amount of copper in the ore taken from the underlie shaft yielded a large profit. Under these circumstances it would be well worth driving from the underlie shaft, and then sinking, as the gossan seems to be on a fissure.

6. CONCLUSIONS.

While the reefs inspected give no promise of permanence, there is always a possibility that permanent reefs (fissure veins, crush zones, or replacement zones) may be discovered in the district, and the fact that the segregated quartz carries good values in places would augur well for the future of such if discovered.

The large amount of quartz on the surface has given rise to the idea that a small battery erected in the neighbourhood might prove a remunerative investment. If all the quartz in sight carried even 10 dwt., there would be little doubt about it, for there is a splendid water supply in the Perry River, and stone could be carted from all over the scrub at a cheap rate, owing to the numerous timber tracks intersecting it. Unfortunately, it is only a small portion of the quartz that would carry even 10 dwt.

As an example of the difficulties under which prospectors labour here, it may be mentioned that they pay 25s. per ton for carting to Gin Gin, 12s. per ton railage to Aldershot (after the first free trial parcel of 5 tons), and then 8s. carting and crushing at Aldershot—a total of £2 5s. per ton without including assay and sampling charges—leaving little out of £3 12s., the value of the gold per ounce, for mining and profit.

My acknowledgments are due to Mr. George Martin, M.L.A., for aid in getting to the field, and to the miners on the field, who rendered every possible assistance.*

LIONEL C. BALL,
Assistant Government Geologist.

25th July, 1903.

*Allowance must be made for any discrepancies between the report and the assays, as this had to be written before the assays were available.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

VICTORIA.

Queensland.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY REPORT,
No. 185.

YOUNG AUSTRALIAN GOLD MINE

AND

COMMONWEALTH BISMUTH MINE,

DEGILBO.

By LIONEL C. BALL, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

BRISBANE:
BY AUTHORITY GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.
1903.

REPORTS ON YOUNG AUSTRALIAN GOLD MINE AND COMMONWEALTH BISMUTH MINE, DEGILBO.

YOUNG AUSTRALIAN GOLD MINE, DEGILBO.

The Young Australian Mine is on the eastern side of portion 53v, Woowoonga, Wide Bay District, just above a small branch of Woowoonga Creek, and 15 chains south of the surveyed road crossing the portion. It is 5 miles by road from Biggenden Railway Station.

A considerable amount of prospecting was done on portion 53v during the year 1901 by an old miner, and, as the result of the finding of rich auriferous shoads and an exposed leader carrying gold, the land was, on my recommendation, reserved from selection. The trenching advised led to the discovery of the reef now worked. Good stone was many years before obtained from the same locality—possibly the same reefs—from two old shafts and several pot-holes a few yards distant from the present workings.

The country consists of highly altered sedimentary rocks (with, in some places, associated granite and porphyry dykes) striking north-north-west, and dipping 70 degrees to the west-south-west. That immediately adjacent to the reef is dark clay slate.

The walls of the deposit are both good, and are 3 feet apart; the footwall is often polished, while the hanging-wall is sometimes "jumbled."

The main reef strikes about east by north, and the dip, averaging 1 in 4, is to the south by east. It varies from 2 to 15 inches in thickness, with an average of 6 inches. The quartz is separated from the footwall by 6 inches of country rock, and towards the hanging-wall it includes numerous fragments of the same, but it does not appear to suffer in richness thereby. The quartz is nice and solid, with a slight purplish tint, and the included slate fragments contain most of the pyrites in the ore, they being sometimes totally replaced by that mineral.

The reef has therefore been formed by replacement on a crush zone, and appears to have "grown" from the footwall towards the hanging-wall. Its continuation in depth may therefore be expected. About 5 tons of ore lay on the surface at the time of my visit, and it was proposed to have it crushed at the Mount Biggenden Mill.

A leader, with good walls, striking about east and west, and dipping like the main reef (1 in 4 to south), was struck in a trench 10 yards to the west by south (approximate) of the main shaft. It carried good gold, and was "surfaced" out to 10 feet depth. This and the main reef should be about 15 feet apart at the top of the shaft, and they should intersect at about a chain to the west of the shaft, near where a strong crosscourse has been exposed.

The new main shaft is now 50 feet deep. At the bottom, just below the water-level, is a short drive to the west; others were opened for a few feet to the east and west, at 35 feet depth; and another at 10 feet depth. The stone has been removed from both sides of the shaft for a distance of 10 feet from it. A total of 20 tons has been crushed for a reputed yield of 3 oz. per ton.

Maid of Erin.

This lies about 10 chains south-west of the Young Australian. A pothole has been sunk on a "mullocky formation," 2 feet thick, between cherty slate above and slate below, and dipping with the country about 60 degrees to the west-south-west. It is probably only a division between two beds, and does not carry gold.

COMMONWEALTH MINE, NEAR DEGILBO.

Introduction.

The Commonwealth Mine lies in about the centre of an old mineral selection, No. 2307, 2½ miles south-south-west of Degilbo Railway Station, with which it is connected by an almost level road. (Degilbo is 58 miles from the port of Maryborough.) The lode outcrops along the crest of a low spur (from Mount Havilah), and is thus in a good position for initial prospecting operations.

The lode was first taken up in 1874 as a copper deposit. A shaft was sunk on the outcrop to a depth of 25 feet, and an adit 4½ chains in length opened from the western hillside about 50 feet below the level of the brace of the shaft, but owing to a fall in the price of copper the ground was abandoned soon after the lode was struck.

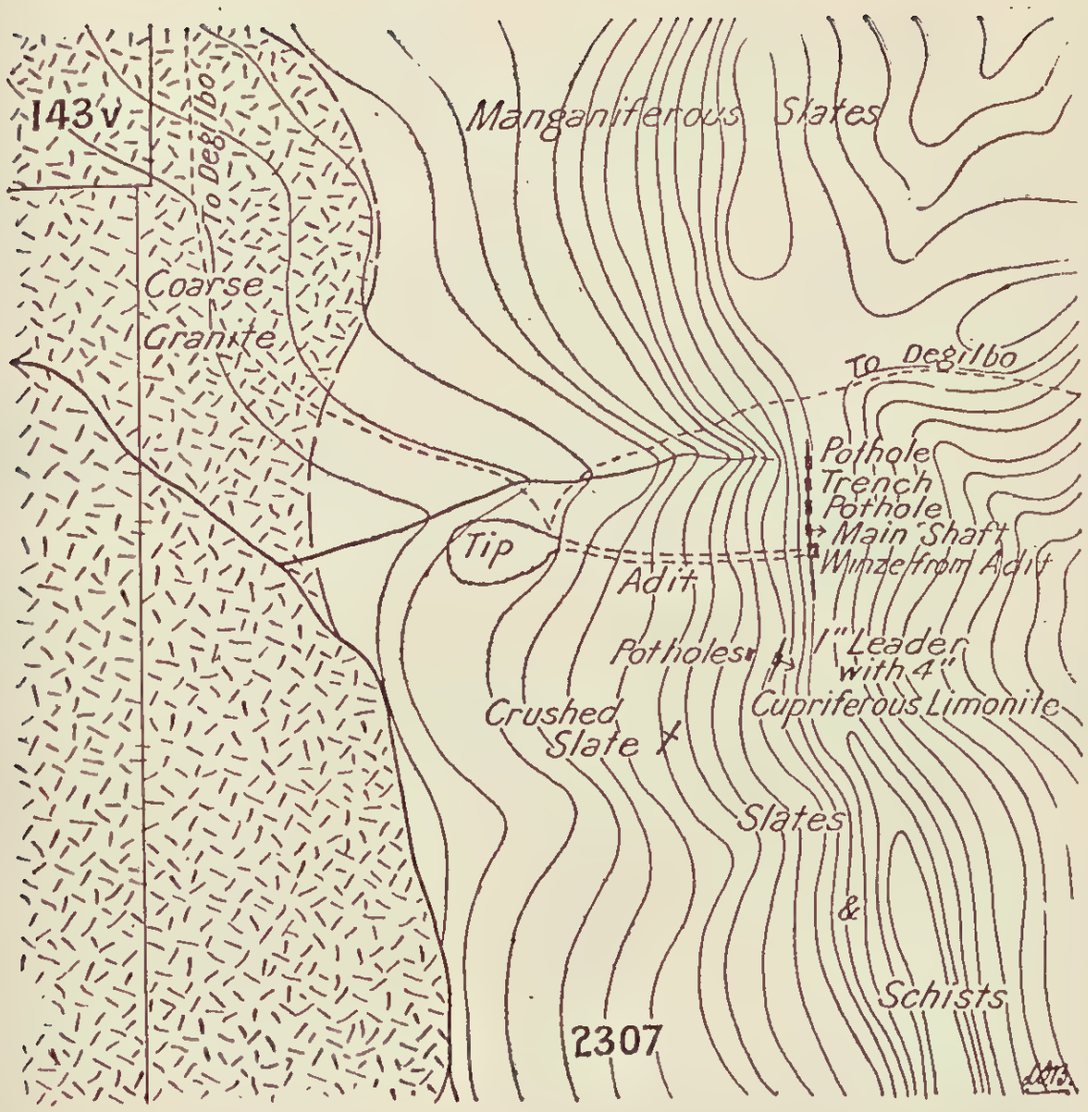
In 1893, 15 tons of carbonate ore was taken from the outcrops to the north of the shaft. Another party of miners secured the mine in 1895. They sank the shaft to the 50-feet level, connected with the lode by a crosscut, drove 2 chains to the north, on sulphide 2 feet in width near the end, and also drove south at the 25-feet level, where there is believed to be good ore. In the following year another party drove a chain and a-half to the north on payable ore on the 25-feet level.

In April, 1902, the abandoned mine was secured as a prospecting mineral area, 400 by 400 yards in area, by four local men, who, after cleaning out the adit, sank a winze to a depth of 25 feet on the lode at the end. They had the ore assayed, and discovered that the unoxidised ore contains a comparatively large amount of bismuth—one assayer giving 7 per cent.—while the average of assays made (probably of picked specimens) gave 7 per cent. copper, 40 oz. silver, and 4 dwt. gold.

At the time of my visit, the shaft was unfortunately inaccessible, and observations had to be confined to the adit and winze and to the surface.

The surface workings on the line of lode are north of the shaft, the first pothole being 7 yards distant, and showing 2 feet of quartz, &c. Three yards north of this is a trench, or collapsed stope, 4 yards long; and 3 yards north of it another pothole.

In a pothole about 2 chains south-west of the main shaft an inch quartz leader, with 4 inches of copper-stained kaolin on the footwall, has been exposed. It dips at a high angle in the same direction as the country rock (to the south-east). The 6 inches of slate next the hanging-wall is strongly ironstained.



Sketch Plan of the Commonwealth Mine, Degilbo.
Scale: 5 chains to an inch.

Geology.

The deposit is on a true fissure, striking north and south, and dipping approximately 1 in 10 to the east. The country rocks—highly altered sedimentaries—strike north-east, and are tilted nearly vertical. The walls of the lode are good, and usually about 3 feet apart, the ore consisting of from 1 foot to 3 feet 6 inches of solid quartz-bearing sulphides.

The genesis of the lode is connected with the intrusion of the mass of granite some chains to the west, so that it is related to the contact deposits of bismuth, iron, and copper ores occurring in the slates adjacent to the granite for some 3 miles to the south. The Mount Biggenden Gold and Bismuth Mine, 1½ miles to the south, is a typical contact deposit of the Christiania type, and has been intermittently worked for several years. In my report on that mine* it was assumed that the iron, at least, was an original constituent of the slates, but in view of the light lately thrown on the subject of ore deposits it seems more probable that practically all the metallic minerals were given off by the intrusive granite and precipitated in the sedimentary rocks by the action of the limestone.

The Commonwealth fissure was probably formed at about the time of the intrusion of the granite, and, if the rock on the junction be calcareous, large

* No. 173 of the Geological Survey Publications.

deposits are to be expected there, and it would be worth while sinking on the fissure simply as a prospecting venture: but, unfortunately, there is nothing to show at what depth the granite will be reached. The slate, besides forming a cap, may extend with wedge form some distance into the granite.

On the adit level the sulphide portion of the lode is nearly on the footwall (being separated from it by 4 inches of soft gossany material), but in depth it gradually passes over on to the hanging-wall. Between it and the hanging-wall is 6 to 12 inches of dark crushed slate, while on the footwall is 12 to 18 inches of broken but not slickensided country.

On the northern end of the winze a strong central fissure can be seen, besides well-defined walls 3 feet 6 inches apart; between the central fissure and the hanging-wall is the ore-bearing quartz, averaging less than 2 feet in thickness, and between the fissure and the footwall is "formation," consisting of soft calcareous and ferruginous crushed and decomposed country rock, at times giving way to ore.

At the southern end of the winze the lode is up to 2 feet 6 inches in width, the formation on the footwall being a foot in width, and sometimes separated from the wall by pug and veins of calcite, but sometimes by a thin sheet ($\frac{1}{2}$-inch) of pyrite, together with a persistent $\frac{1}{2}$-inch quartz veinlet.

At the bottom of the winze the width varies from 1 foot to 2 feet 6 inches, the latter being apparently on the junction with a fissure, now filled with calcite, coming in from the south-east.

Bismuth was first noticed in quantity about halfway down the winze, and it is believed to be increasing with depth, while the silver decreases.

The Ore.

A ton of picked ore was sent to Germany a short time ago for report on treatment, most of the reduction works in Queensland having refused to treat the ore as mined. A cablegram to hand gives the contents of the ore sent as 3.6 per cent. bismuth, 12.1 per cent. copper, and 5 oz. silver per ton, without gold.

A quantity of ore now remaining bagged at the mine consists of quartz, chalcopyrite, pyrite, mispickel, blende, and bismuthinite. A sample was taken from the tops of 80 bags, from which most of the blende with much of the other minerals had been picked out. This was probably not of as good a quality as that sent away. The Government Analyst finds that it contains:—

Copper	...	...	...	3·5 per cent.
Bismuth	...	...	...	1·1 „
Zinc	...	...	...	·3 „
Silver	...	...	...	6 oz. 13 dwt. 8 gr. per ton.
Gold	...	...	...	... ... 16 „ „

Assays for the owners from the adit level have given as much as 70 oz. of silver.

Treatment.

Mechanical treatment only will be necessary for the ore locally, as the product from the mines, or a concentrate, will have to be exported. Concentration by jig or table would be advisable to reduce the amount of quartz and gangue generally before shipment. The specific gravity of both chalcopyrite and blende is approximately 4.1, while that of bismuthinite is 6.5, and of quartz only 2.6. There should, therefore, be no great difficulty in separating the

bismuth ore from the chalcopyrite and blende, and the last two from the quartz obtaining a concentrate high in bismuth and one high in copper and zinc. It will be necessary to ship the bismuth concentrates to London or Saxony, as the market is completely controlled from there, and the local metallurgical treatment of the ore is not to be thought of.

It is doubtful whether, if the gangue only is removed, any allowance will be made by the bismuth purchaser for the copper and zinc contents on account of the great difficulty of treating a mixture of ores of those metals, and also because of the ill-effects of a minute quantity of bismuth on the copper.

Even if it is not possible to sell the ore as mined, there is no reason why an attempt should not be made to separate the bismuth, and it may then be possible to secure a purchaser for the zinc and copper concentrates.

Owing to the crushed "formations" on each side of the lode, exploitation will not be costly, but even then a small lode carrying only 1 per cent. of bismuth could scarcely prove payable. Three and a-half per cent. of bismuth should, however, give big profits, even without considering the accompanying metals. The latest available quotations of the price of bismuth is 8s. 9d. per lb., and it has not been below 7s. 6d. for many months past. The gross value of the metals in the ore is, according to my sample, roughly £18, while, according to the parcel sent to Germany, it is £42 per ton.

In conclusion, attention must be called to the fact that very little development has been done on the deposit, which has been traced for only 2 chains on the surface, and proved to a depth of only 50 feet, while the greater part of the old workings are inaccessible.

Brisbane, 2nd October, 1903.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane

NATIONAL MUSEUM VICTORIA

Queensland

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY REPORT, No. 186.

I.—LATE DISCOVERY OF GOLD NEAR PRATTEN, TALGAI GOLD FIELD;

II.—SOME MINES ON THE TALGAI GOLD FIELD;

AND

III.—DISCOVERY OF GOLD AT MOUNT STURT AND FREESTONE CREEK, WARWICK DISTRICT.

By LIONEL C. BALL, B.E.,

ASSISTANT GOVERNMENT GEOLOGIST.

BRISBANE:

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1903.

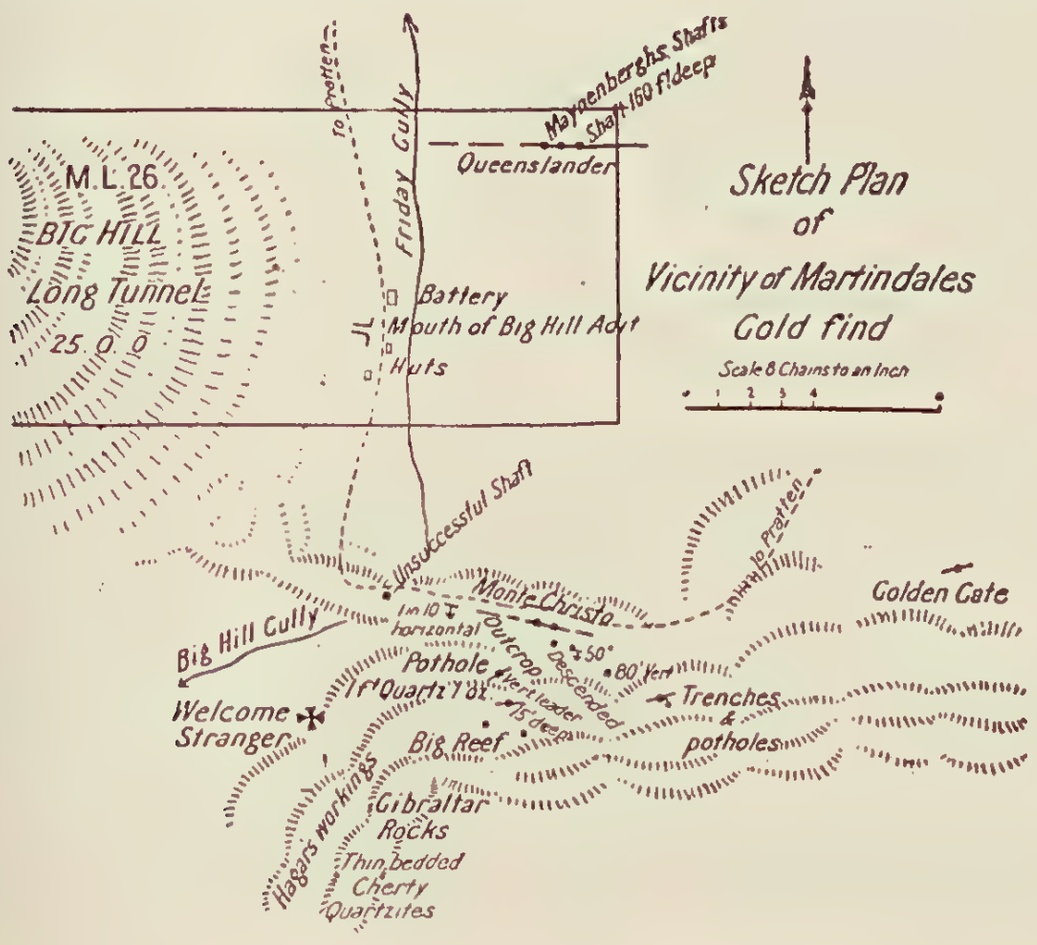
LATE DISCOVERY OF GOLD NEAR PRATTEN, ON THE TALGAI GOLD FIELD.

Locality: Pratten, the only township on the Talgai Gold Field, lies on the edge of the alluvial flats west of the Condamine River, 19 miles west-north-west of Warwick.

The goldfield is a very irregularly-shaped tract of 77 square miles. Twelve main lines of reef—the Malakoff, Louisa, Sultan and Taylor, Prince of Wales, Big Hill, Queenslander, Monte Christo, Australian, Gladstone, St. Patrick, and Guiding Star—have been held at various times. The Louisa, Sultan and Taylor, and Prince of Wales are now abandoned, but preparations are being made to start work at the Malakoff, Big Hill, Gladstone, and St. Patrick, while actual exploitation is going on only in the Australian. Prospecting operations are, however, being carried on at numerous points between Big Hill and Pratten.

History: In June last, Mr. G. Martindale, a prospector on the Talgai Gold Field, obtained a number of ounces of gold from a small hole less than 3 feet deep in clay and rubble, 12 chains south of the Big Hill Mine, which lies 3 miles west of Pratten. On his securing a lease (the Welcome Stranger) of 2 acres, a small "rush" took place, chiefly owing to the prominence given the matter in the papers. Nine ounces to the bucket were mentioned as being got from a gossan formation new to the district. It was also thought that the find was "the source of the alluvial gold found round Pratten."

Colours of gold were obtained on the north and east of the Welcome Stranger, in the latter place occurring in stringers in cherty quartzite, but nothing worth sinking on was found.



In the beginning of July, Martindale sold his lease to a Brisbane syndicate, who also bought the adjoining claims, including the old Monte Christo line, totalling 25 acres.

A few days later gold was found within a quarter of a mile to the east of the first discovery, and a lease (the Golden Gate) of 5 acres was taken up. No sensational prospects were obtained, but all the adjacent land has since been leased for mining purposes.

Welcome Stranger.

Martindale's attention was probably directed to this locality because of the re-starting of operations at the Big Hill Mine, the known occurrence of a number of auriferous reefs in the immediate vicinity, and the fact that several gullies on the west and north of Big Hill had been profitably worked at various times during the last thirty years. He made the discovery by following up a branch of Dunn's Gully till he found colours, then tracing them up the hillside to the east, and sinking the hole just above where he failed to find gold in the soil. Martindale himself told me that from the single pothole opened he extracted 40 oz. of gold before handing the ground over to the syndicate. It seems probable that this was nearly the whole of the bunch of gold, for reports to hand since my departure from the field refer to gold in a reef having been *again* struck at 10 feet depth. As the hole had been partly filled in, I was not able to see whether a lode had been proven, as reported. One dish of earth from the side of the hole, washed off by Martindale, gave several colours, but a better prospect was obtained from the soil, over a width of 12 feet, down the slope below the hole for a distance of a chain. It was proposed to put this soil, to the amount of 70 tons, through one of the local batteries. The boundary of the lease is about a chain below the rich hole (*i.e.*, to the west), and a little dry-shaking has been done outside it without very profitable returns.

The probability is that the hole was opened on the outcrop of a rich but narrow shoot in a reef making no show at the surface, but most likely on a fault striking down Friday Gully between the Big Hill and Queenslander workings. The reason for no work having been done up till the time of my visit was that the lease had to be secured, thirty days being allowed for objections. The manager had just arrived at the mine with six men, and proposed to start operations at once.

The country rock on the Welcome Stranger is, as far as can be seen, altered slate and quartzite, with no sign of igneous rocks.

Monte Christo.

Since the discovery of the Welcome Stranger, a little prospecting has been done between it and the Monte Christo, a few chains to the north-east. The Monte Christo reef, discovered in 1864, has been reported on several times since its final abandonment in 1890. Its general strike appears to be about west-north-west (though Mr. Skertchley* gives it as west by south), and its dip from 40 to 60 degrees to the south-south-west; and it varies from 3 inches, as can be seen now, to 7 feet, according to report. The country rock is a light, rotten, sandy material, and appears microscopically to be a sandy clay slate, but it has a great resemblance to a decomposed felsitic volcanic rock. It is

* On the geology of the country round Stanthorpe and Warwick, &c., with special reference to the goldfields, &c.—By Sydney B. J. Skertchley, late Assistant Government Geologist, Brisbane. By Authority: 1898.

worthy of note that similar rock is to be seen at several places as far south as the St. Patrick Mine, and Mr. John Clare informed me that reefs, auriferous while in it, become barren when passing into other country. It would require considerable time and accurate surveying to come to definite conclusion as to the nature and extent of the rock.

Three main underlie shafts were sunk on the outcrop, and three vertical and underlie shafts at various distances in the hanging-wall country. In the only shaft that it was possible for me to descend, the reef was struck at 20 feet depth, and then followed on the underlie. Where first struck it is little more than an ironstained fissure, but the inclination gradually increases from 45 to 60 degrees at 50 feet depth, where the reef is 3 inches thick. Little or nothing can be learned from the other shafts because of their dilapidated condition.

Mr. Skertchley, in his 1898 report,* refers to two shafts 90 feet apart, an eastern whip shaft vertical for 40 feet, and a western main shaft vertical for 18 feet; they were carried on ths underlie for 120 feet, and connected at the bottom by a drive in which the reef widens to 7 feet. In the main shaft very little gold was found below 45 feet, but the stopes gave, during 1890, the following crushings:—

15½	tons,	yielding	106½	oz. of gold,	valued at	£396.
18	„	„		„	„	£375.
6	„	„	6	„	„	

Mr. Skertchley, in a diagram, demonstrates that, "save a connecting drive between the shafts and a small 26-feet crosscut at the bottom of the whip shaft, no development whatever has been undertaken. . . . There may be as much gold remaining in the untouched reef . . . as has been taken out of the mine."

Trenches and potholes have been opened, some of them within the last few months, on three quartz reefs within 5 chains south of the Monte Christo reef, but sufficient prospecting has not been done on them to form any decided opinions. One of them, 2 chains from the main line, the prospectors believe carries an ounce of gold per ton. It is a replacement quartz reef, and specks of gold can be seen in some of the stone from it. There are half a dozen pot-holes, one 15 feet deep, but very little can be learnt from them, because they are either flooded, collapsed, or too shallow.

It has been proposed to sink a shaft midway between the Welcome Stranger and the Monte Christo, and from it to crosscut to the reefs, but some prospecting should first be done on the former. Another proposal is to prospect the Monte Christo reefs by an adit from the south side of the ridge, and, as the reefs are dipping in that direction, the project seems a good one, especially as at least 200 feet of backs might be made available; but here again, before attempting such an expensive undertaking, more should be known about the outcrops of the reefs.

Golden Gate.

Colours of gold can be found in the soil at several points on this lease. The prospecting hole lies 20 chains east-south-east of the mouth of the Big Hill adit, and a similar distance east-north-east of the Welcome Stranger. At the time of my visit, the hole was 3 feet deep, and, having been sunk among the roots of a gum-tree, was in somewhat disturbed ground. The reef, in a rubbly clay, and seemingly dipping 30 degrees to the south, is about 18 inches thick, and gives good prospects on dollying. Martindale proposed, on the

* Op. cit.

expiration of a month's exemption, to sink a shaft a few feet away from the reef. Word was received from him at the beginning of this month (October) that, at a depth of 12 feet, he had cut a 15-inch reef showing gold and striking slightly south of west.

Five-acre leases have been taken up on the north, south, and east of the Golden Gate.

Work is being carried on at the No. 2 East Golden Gate, a quarter of a mile east of the prospecting area. Good prospects of gold are being washed from the surface soil, a chain south of the line of the Queenslander reef, here running east-south-east, but neither reef nor leader has yet been discovered. The country rock is clay slate.

It is difficult to give an opinion on the value of Martindale's discovery before any work has been done. There is promise of a new reef, having at least one rich "shoot," and the opening up of this may lead to the discovery of others. The Monte Christo line has yielded good prospects in the past from the stone above water-level, of which only a portion has been removed, and modern methods may succeed in treating the stone below the water-level, though we know very little as to the average thickness and richness of the reef.

The reefs generally in the vicinity have been characterised by small rich shoots, and mining in the past has failed because operations were on such a small scale that prospecting ahead of the workings to locate new shoots could not be undertaken.

An exact or detailed survey of the ground was not attempted by me because the time at my disposal would not allow it, and because the amount of prospecting work done did not warrant it.

A brief account of the mines in the vicinity of Pratten is now in preparation.

4th October, 1903.

SOME MINES ON THE TALGAI GOLD FIELD.

The various mines described below were seen while on a visit to investigate the late discovery of gold near Big Hill.

The Talgai Gold Field suffers from being one of the oldest in Queensland. In the very early days some phenomenally rich reefs were worked, usually by a number of small claimholders, who, on reaching water-level, abandoned the reefs. Thus it is now found that not alone has the rich surface stone that should pay for plant and development been removed, but that, owing to the collapse of the old workings, it is not possible to ascertain definitely the quantity and quality of the stone left without going to considerable, and often prohibitive, expense.

There is now hope, however, that the Big Hill and Monte Christo companies intend to try the reefs on their leases, and a determined attempt is being made to cut the Gladstone reef below the old workings.

BIG HILL LEASE.

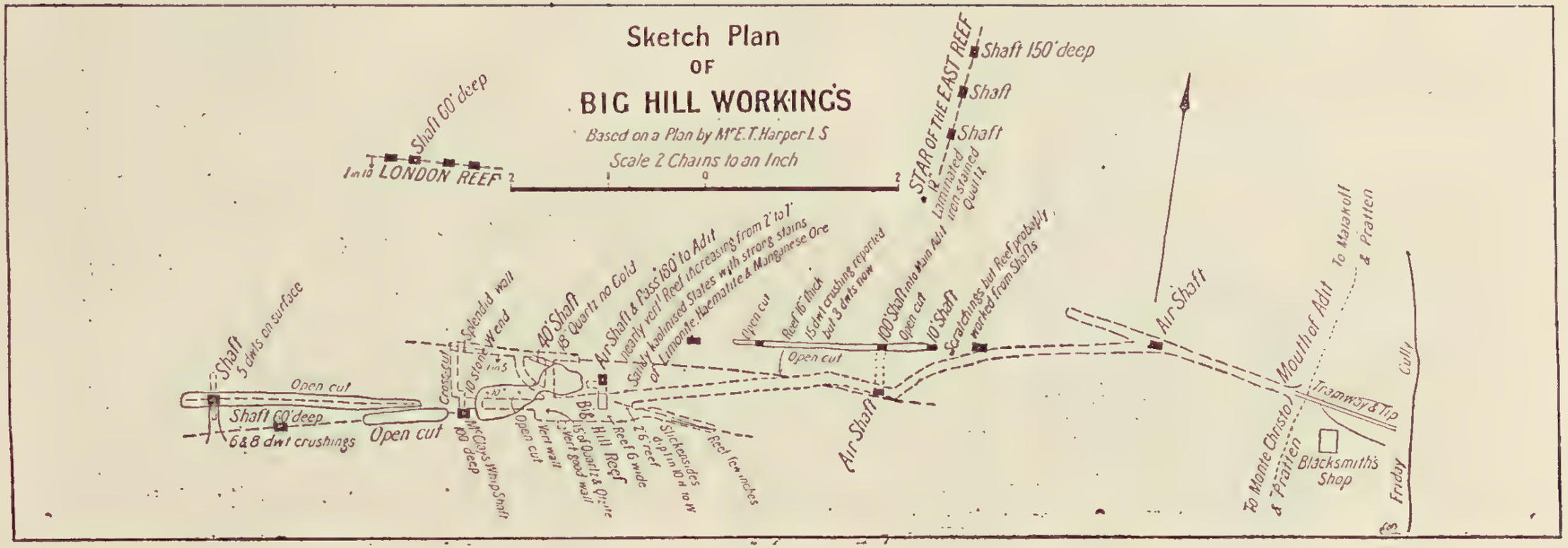
Locality: Big Hill itself lies 3 miles west of Pratten, and has an elevation of nearly 900 feet above that town. The present lease of 25 acres, secured in 1897, is on the eastern side of the hill. It includes the following lines of reef:—The Big Hill and branches, Victory, London, Star of the East, and Queenslander.

Big Hill and Victoria Reefs.

The first stampers on the hill were erected in 1864. Since that year several spasmodic attempts have been made to exploit the reefs, but no work to speak of has been done for the last twelve years. A Thompson centrifugal crushing-mill, capable of putting through 2 tons an hour, is now being erected, with the view of trying the low-grade material, of which the greater part of the Big Hill reef consists. Several thousands of tons of stone from the stopes about where the reef splits up into branches were raised in the early days and crushed at a profit.

Three of the branches can now be made out in the old stopes (one in McClay's whip shaft, at 100 feet depth, being 11 feet wide), with a large number of intermediate stringers between them, all apparently on fissures. It is probable that the stringers carried the larger part of the gold, the richest ground on the Victory being similar in character. West of McClay's shaft the branches are unfavourable in appearance, and are acknowledged to be very low-grade as a whole, any work done having been on leaders. East of the stopes the reef was found to be only 2 feet thick on the surface, though in the adit, 180 feet below, it is 7 feet thick; but on that level also it pinches down to a few inches within a chain to the east.

The reef, however, in the adit increases to as much as 15 feet a few yards to the west. The development of auriferous stone occurs at the intersection of several fissures; or, in other words, the gold-bearing quartz was deposited in a considerably shattered portion of the country.


Sketch Plan
OF
BIG HILL WORKINGS
Based on a Plan by Mr E. T. Harper L S
Scale 2 Chains to an Inch
Shaft 60' deep
Into LONDON REEF
STAR OF THE EAST REEF
Shaft 150' deep
Shaft
Shaft
12' Laminated iron stained Quartz
Shaft 5 dwts on surface
Open cut
Shaft 60' deep
6&8 dwt crushings
Open cut
Crosscut
10 stone Wend
Splendid wall
40' Shaft
18' Quartz no Gold
Air Shaft & Pass 160' to Adit
Sandy kaolinised States with strong stains of Limonite Haematite & Manganese Ore
Open cut
Reef 16' thick
15 dwt crushing reported but 3 dwts now
100' Shaft into Main Adit
Open cut
10' Shaft
Scratchings but Reef probably worked from Shafts
Open cut
Air Shaft
Air Shaft
Mouth of Adit
To Kaiakoll & Pratten
Tramway & Tip
Gully
To Monte Christo & Pratten
Blacksmith's Shop
Friday
Big Hill Reef
15 of Quartz & Oxide
Vert wall
Vert good wall
Reef 6' wide
2' 6" reef
Slickensides dip 1 in 10 N to W
Reef few inches
McClays Whip Shaft
100' deep
Open cut

The quartz is in part very promising looking, with clay seams, while the walls are both slickensided and flucanised. The reef is almost vertical, any dip that does occur being to the north.

The Victory has been worked on the surface for a distance of 3 chains. The five shafts opened in the early days are now inaccessible, but the caving-in ground between them tells of a considerable amount of stoping having been done. On the level of the main adit the reef consists of promising white and ironstained fissured quartz, with a splendid footwall, but no defined hanging-wall. In places it breaks up into a number of separate stringers, and is up to 8 feet in width, the average of that which is exposed being 6 feet. A thousand tons are said to have been crushed from the reef on the adit level for over an ounce per ton.

Workings: The workings on the main reefs consist of two open cuts, ½ and 2 chains long; collapsed stopes, 1 chain long; a dozen shafts; an adit, 8½ chains long; and various crosscuts. The open cuts are on branches of the Big Hill vein. Most of the shafts are on the Victory, but both reefs were exploited from the stopes and adit. (*See* Plan.)

Little of any promise is to be seen in the two western open cuts, the quartzite exposed being believed by the manager to carry 5 dwt. of gold per ton near the surface. The larger western cut is 10 to 15 feet deep, on a horse of quartzite 7 feet wide, with laminated quartz on both sides; that on the north, yielding colours of gold, being over 10 feet wide, and dipping about 1 in 3 to the north, while that on the south, up to 2 feet wide, dips 1 in 5 to the south. A crushing of 4 tons was taken three years ago from the western end of the cut, where the horse seems to pinch out, and yielded 4 oz. of gold.

Mr. Rands* speaks of a large amount of stone from this cut having yielded 1 oz. per ton.

The westernmost shaft, 11⅓ chains from the mouth of the adit, is in this cut. It is 60 feet deep, with 8 feet and 12 feet crosscuts, on the south and north respectively, to the reefs, the southern of which was proved to be 4 feet thick. The first 20 feet of the shaft is accessible, and in it can be seen a reef varying from 6 inches to 2 feet. Some stoping has been done on this for 20 feet to east and west.

Another shaft, within a chain east of the above, on the southern branch of the reef, is reported to be also 60 feet deep, and to have yielded 6 and 8 dwt. crushings.

McClay's whip shaft was sunk at the junction of the two branch reefs to a depth of 100 feet. It was the only other accessible shaft at the time of my visit. In it the footwall of the deposit is seen to be always well-defined, with horizontal slickensides and attached gossan, while the hanging-wall is only sometimes to be seen. At 80 feet depth, 6 feet of quartz is believed to carry 5 dwt. per ton; below it averages 9 feet in width. Mr. J. Clare gave me the following list of crushings obtained from it within 20 feet on both sides of the shaft:—

100	tons for	...	...	...	8 dwt.	0 gr.	per ton.
100	„	...	...	...	7 „	0 „	„
200	„	...	...	...	6 „	6 „	„
200	„	...	...	...	5 „	12 „	„
100	„	...	...	...	3 „	0 „	„
700	„	...	(average)		6 „	0 „	„

* Big Hill Gold Mining Company's lease, Talgai.—By William H. Rands, Assistant Government Geologist, Brisbane. By Authority: 1898.

A winze has been begun to connect the shaft with the end of the main adit.

The stopes, extending for a chain to the east of the shaft, have now fallen in, leaving a chasm 50 feet deep and 20 feet wide.

A 30-feet crosscut from the bottom of the shaft has struck the Victory reef where it is 2 feet thick, but practically barren.

Just beyond the eastern end of the McClay shaft stopes a shaft connects with the adit, but beyond that no surface work whatever has been done on the Big reef. The Victory reef has, however, been sunk on and stoped to an average depth of 50 feet for over 3 chains to the east, and has evidently paid well to work. None of the shafts could be descended, but it is believed that the reef decreased in thickness with depth.

The adit is about 180 feet below the surface of the upper workings; originally it was meant to cut a cross reef, the Star of the East, at a calculated distance of 4¼ chains, but the adit was discontinued at 2½ chains, and a branch tunnel was carried obliquely to the Victory (4½ chains from the mouth of the adit), and beyond it to the Big reef (cut at 7 chains from the mouth). The Victory, 16 inches thick, proved poor where cut, but, to judge from the large amount of stone taken from the Big reef, it must have been payable. The latter, where first cut, was 7 feet thick, and was followed to the west for a chain. Its width was proved in one place to be 13 feet, but east of where first cut the reef quickly pinches down to 2 feet 6 inches, while within a chain its thickness is reduced to a few inches. Crosscuts from near the end of the adit connect with the Victory reef, which is 30 feet to the north, and which has been driven on for over a chain. Its width varies from 4 to 8 feet, and several hundred tons of stone were obtained from it. Further prospecting to the east is necessary.

The Warden, in his report for 1887, refers to 1,000 tons from the adit having yielded 15 dwt. per ton.

The reefs are undoubtedly on true fissures, their general strike being almost at right angles to the altered sandstone, quartzite, and slate country, the metamorphism of which has evidently been caused chiefly by earth movements, for igneous rocks are conspicuously absent from the immediate vicinity; even in the whole district they are represented by only a few diorite and porphyrite dykes. There is thus every probability that the reefs will continue to indefinite depths.

The reasons given for the abandonment of the mine are—its comparative poverty, the distance (3½ miles) to the nearest battery, and the fact that all the surface stone has been removed, and the workings left in a dangerous state. No attempt was made by me to sample the mine, both because of the time it would require and because it was hoped that an exhaustive survey might be undertaken when work has again been begun, and when many parts now inaccessible may be reached. The best test will, of course, be given by putting large parcels from the different parts of the mine through the mill now in course of erection, though much expense might be saved by judicious preliminary sampling and assaying.

Star of the East Reef.

The workings on this reef (several inaccessible shafts, one of which is reported to have been 150 deep) lie 4 chains west-north-west of the mouth of the Big Hill adit. The reef strikes about north-east (shown on the plan as north-north-east), and seems to be vertical. There is over a foot of laminated ironstained quartz.

London.

The London lies 2½ chains north of the main Big Hill open cut. There seems to be 3 feet of material between the walls of an east and west fissure, dipping 1 in 10 to the south. It is believed to have carried 8 dwt. of gold per ton, and to have averaged 2 feet in thickness.

Queenslander Reef.

If continued west beyond where worked, the Queenslander would pass within 6 chains to the north of the Big Hill line, but it has probably been cut off in Friday Gully by a north and south striking fault. The main workings lie 8 chains north-east of the mouth of the adit, and consist of a number of shafts (three main ones, the deepest said to be 200 feet) and surface workings. The last development was done before 1869.

The reef was opened in 1863, and has at times given phenomenal crushings —90 tons for 1,100 oz.; 4 tons, from 70 feet depth, for a total of 600 oz.; several crushings from the 130 feet underlie, for over 4 oz. per ton; and 1 ton from the 50-feet level for 444 oz. The total to 1887, given by the Warden in his annual report, being 400 tons for an average of 5 oz. per ton. Besides having these rich bunches, the reef was reported to carry good gold to a depth of 100 feet, with fair prospects to 130 feet, beyond which, though large, it was believed to be poor. There are other reports* that a large pyritous reef came in from the north at a depth of 100 feet, and that in the deepest shaft the reef became too small to work.

The reef is nearly vertical (dipping in parts 1 in 5 to the south), and strikes east and west; it splits towards the west. Ten or twelve shafts were sunk on the western end in the old days by small claimholders. The reef is believed to extend for over a mile to the east and east-south-east, but has not been proved payable beyond the Big Hill lease.

The central main shaft is now open to the 60-feet level, on which a drive can be followed for 100 feet east and west. The average width of the reef is 6 inches, the quartz being streaked with blue and of a promising appearance. The footwall country is sandy clay slate, while quartzite forms the hanging-wall on to which the quartz is "frozen."

At the present time the mine is being utilised as a reservoir by the Big Hill Company, but they propose, when their dams are completed, to pump it dry, and to thoroughly prospect it.

AUSTRALIAN CLAIMS.

The Australian reef, which is almost vertical (any dip being to the east-south-east), and strikes north-north-east, is crossed on the Big Hill track on the head waters of Gum Flat, 2 miles west of Pratten. The country rock is clay slate, almost black in colour, owing to the large amount of contained pyrite, and the quartz of the reef appears to have metasomatically replaced this country.

The workings point to the ore being rather towards the south, in which direction the shoots pitch.

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* "Geology of the country round Stanthorpe and Warwick."—By Sydney B. J. Skertchley, Assistant Government Geologist, Brisbane. By Authority: 1898.

Four shafts have been sunk on the P.C., the main, or No. 4, being on the ridge top; the prospecting shaft in the gully, 2 chains to the north; the No. 2 shaft, a chain north of the main shaft; and the No. 3, half a chain beyond it.

The No. 2 shaft was opened on a 4-inch leader, which suddenly, at 10 feet depth, increased to 18 inches in width, and continued to increase till, at the bottom of the shaft, 20 feet from the surface, it is 4 feet thick. A drive connects this shaft with No. 3.

In No. 3 shaft, the reef pinches at 40 feet depth, and does not increase above the bottom (at 60 feet depth). Southward the reef bulges below the 40-feet level, the "makes" pitching in that direction.

The No. 4 shaft is 80 feet deep, but now (August) is flooded below 60 feet. The reef has not well-defined walls, and is very liable to vary greatly in its thickness. Bunches of ore, up to 3 feet thick, pitch to the south-west at angles of 20 to 30 degrees all the way down the shaft. It is reported that there is 15 inches of quartz in the sump, carrying 13 dwt. of gold per ton. The ore in the paddock, from near the bottom of the shaft, shows that there must be 12 to 15 inches of laminated quartz, with additional massive quartz carrying angular slabs of partly replaced slate. Very good prospects can be washed from this stone. The first crushing of stone, from within 15 feet of the surface, paid for the sinking of this shaft. The two last crushings, obtained from within 20 feet of the shaft, consisted of 6½ tons, yielding 5 oz. of gold per ton, and 8½ tons, yielding 3½ oz. per ton. A third crushing from a still lower depth is now being raised.

Mr. Jackson, in his annual report for 1902,* gives the following yields:—

50½	tons crushed in	1899	for	84 oz.	12 dwt.
40½	„	„ 1890	„	105 „	1 „
63½	„	„ 1891	„	65 „	4 „
154½	„	„	„	254 oz.	17 dwt.

This mine is a promising one, and worth exploiting on a larger scale than at present. Though the walls are not, as a rule, well-defined, the reef is on a fissure, so that there will be no likelihood of its cutting out altogether at any moderate depth. The present owners have had some trouble through allowing the workings to become flooded during the recent rains, but it is believed that no difficulty will be experienced in removing the water.

A shaft is being sunk on the No. 1 North, 1 chain from the prospecting shaft, but the reef has not yet been struck.

A considerable amount of prospecting has been done in the vicinity of the Australian. Numerous potholes have been opened on the south-east in indurated yellowish clay slates, but payable stone does not seem to have been found.

On the "short cut" bridle track to Big Hill, a quarter of a mile south-east of the Australian, is a vertical reef, striking west-north-west, and averaging 4 inches in width. It was worked three years ago, but pinched at a depth of 40 feet, and, though proved to increase again, it was abandoned because of its poverty. A crushing of 12 tons is said to have yielded 2½ oz. of gold per ton. The reef has lately been re-prospected, and gold has been found to the west of the old workings. The country consists of similar mottled slate to that at the Louisa, and the quartzite in the neighbourhood has been found to contain colours of gold.

* Annual Report of the Under Secretary for Mines for the year 1902.

Trenches were opened many years ago a quarter of a mile north-west of the above, near the same track, on 9 inches of white quartz with partly replaced slate. The strike of one reef is east and west, and of another north-west and south-east.

GIBSON'S CLAIM.

P. A. 36 lies a quarter of a mile north of the Thane's Creek road, 3 miles west of Pratten, and half a mile south of the Australian. It has been held for the last eighteen months, but is now deserted.

The reef strikes east and west, dipping 1 in 3 to the south, and has been proved for about 2 chains. Mr. Jackson, in the report referred to, mentions that a flat shoot, dipping east, was worked, and it is believed locally that the gold in the reef died out in undecomposed country (greenish sandy clay slate).

The main shaft, originally 60 feet deep, but now open to only 25 feet, is on the eastern end of the workings. There is a good hanging-wall, and 3 feet of stuff between it and the footwall, 9 inches of which, on the hanging-wall, is formation. No quartz can now be distinguished, it having been probably all stoped out.

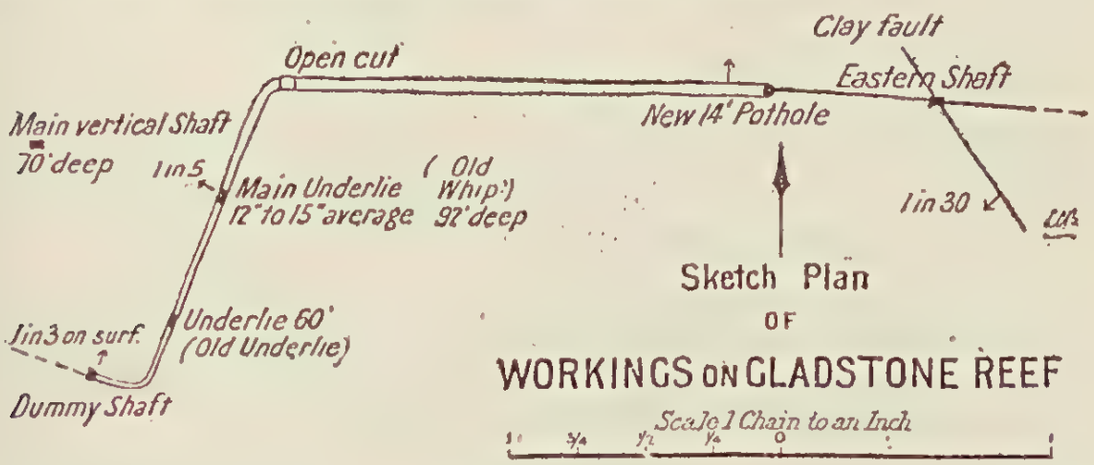
A small three-head battery stands at the mine, but the engine has lately been removed. A total of 40 tons is given by Mr. Jackson as having been crushed to the end of 1902 for an average of ½-oz. of gold per ton.

CLARE'S CONSOLS.

A Gympie company is sinking a shaft beside the Thane's Creek road, 3 miles west of Pratten, in altered kaolin-bearing sandstone, in order to prospect for the reef or reefs which shed the rich alluvial gold formerly found in the vicinity. It is probable, however, that the gold was shed from numerous minute leaders, and there is little hope of a payable reef being found.

GLADSTONE CLAIM.

The Gladstone Mine lies a little over 5 miles west of Pratten and 10 chains north of the Thane's Creek road. It was opened some time previous to 1887, and is therefore one of the oldest mines in Queensland.



The country rock is bluish clay slate, with belts of quartzite, the strike of which could not be determined. Dr. Jack* speaks of the reef being from 6 to

* Annual Progress Report of the Geological Survey for the year 1891.

10 inches in thickness to a depth of 60 feet. The general course of the reef is about east and west, but there is one sharp bend almost at right angles to the general course, in the vicinity of which the reef seems to have been richer than elsewhere. (Dr. Jack gives a different strike to the above.) The dip is to the north, and varies from 1 in 3 at the west to 1 in 30 at the east, gradually becoming greater, as a rule, with depth. Mr. Kerrige, the present owner, believes that the shoots of rich stone (all of which dip west, and vary from 15 to 20 or 30 feet in length) carry from 1 to 2 oz. of gold per ton, while the stone between the shoots carries an average of 15 dwt. per ton.

Seven underlie shafts have been sunk on the reef, and a vertical shaft was begun by the former owners in the hanging-wall country. (*See* plan.) A large amount of stoping has been done near the surface, chiefly on the western portion, and, owing to the removal of most of the supporting timbers, much of the ground has caved in, rendering entrance to the workings difficult or impossible.

The main underlie (Dr. Jack's whip ?) is reported to have been 92 feet deep, but is now open to only 30 feet, where 12 to 15 inches of quartz is visible between good walls, dipping 1 in 5 to the west-north-west. Dr. Jack refers to 10 inches of good quartz on the footwall beneath 10 inches of poor red-jointed quartz. Practically all the stone near this shaft, above the 60-feet level, has been raised, but little from below.

In the most western shaft on the line (the Dummy shaft) the dip is 1 in 3 to the north by east, the visible upper 20 feet of the reef being only a few inches thick, but the walls are good. At the above rate of dip the reef should be struck in the main vertical shaft (14 paces distant) at a depth of 125 feet, but if the dip increases, as is most probable, it may not be reached at less than 200 feet, as expected by the miners who began the shaft.

In the eastern shaft the reef (dipping 1 in 30 vertical) increases from a few inches at the surface to 9 inches at the 40-feet level, below which the mine is flooded. A drive at a depth of 30 feet was opened for 15 feet to the east, but the reef pinched to 6 inches, and the gold, reported good near a fault at the shaft, gradually became poor.

At the 40-feet level a prospecting drive, now only partly open, was carried for 2 chains to the east. It is reported that there is a shoot of gold 35 feet west of the shaft.

The second underlie (Jack's windlass?), near the western end, is 60 feet deep, and becomes more nearly vertical with depth. A drive was carried 50 feet to the west from it, the reef pinching at the end. Dr. Jack says that the shaft was sunk on a rich shoot in a 6-inch reef, and that at 30 feet depth a drive was opened for 30 feet along the reef.

The vertical shaft is well-timbered, and has two compartments, each 4 feet square; its present depth is 70 feet. Assistance has lately been granted by the Mines Department to the present owner to sink this shaft to about 120 feet, where, if the reef is not met, a crosscut will be opened to it.

The mine is reported to have been abandoned because the appliances on hand were incapable of overcoming the water, but it is believed that the pump now on the ground will be able to cope with the difficulty.

A small three-head stamper battery is now at work at the mine, and it is intended to transfer an eight-head battery from Pratten when the reef is struck.

ST. PATRICK CLAIMS.

St. Patrick P.C.

The St. Patrick workings lie 1 mile south-west of Pratten on a reef which was discovered by trenching in 1892. The strike is a little north of west, and the underlie 60 degrees to the south. (*See* plan.) Near the surface the country rock for a couple of chains on each side of the reef is a sandy kaolinised rock.

Sketch Plan
OF
SAINT PATRICK & SAINT PATRICK NORTH REEFS
Scale 2 Chains to an Inch

The western workings consist of five underlie shafts near the outcrop and four at different distances from it on the hanging-wall side. (*See* plan.) The richest shoot was at the western end of the workings, and the collapsed stopes show where 3-oz. stone existed (to a reported depth of 20 feet). The shoot pitched to the east, as did also the cap of the reef. Beyond the reef to the west the reef is considered too low-grade to work.

The main underlie, half a chain to the east of this, is 92 feet deep, with a drive for 110 feet to the west on the main shoot, which is said to have been worked out to a depth of 120 feet. A parcel of 14 tons from the 60-feet level are given as having yielded 28 oz. 14 dwt. The shaft is now flooded below the 60-feet level. The average width of the reef in the shaft is 10 inches, but at about 50 feet depth it is only 3 inches. The hanging-wall is well polished, but the footwall is not distinguishable. The reef on the east of the shaft is broken up by soapy heads.

The No. 2 West shaft is now 140 feet deep, the reef having been cut by a vertical shaft at 30 feet, and then followed on the underlie. Mr. Skertchley saw that the reef carrying free gold in places varied from 3 inches to 2 feet in thickness, and that it was on a true fissure. It lies half a chain south-west of the collapsed stopes referred to.

The main shaft is 1 chain south of the stopes; in it the reef was cut at 102 feet depth, and was followed with Government aid for 100 feet on the underlie. It averaged 10 inches in thickness, and carried from 18 dwt. to 2 oz. of gold per ton, with an increasing amount of concentrates—a ton of which yielded 7 oz. 14 dwt. of gold. Mr. Clare, who now holds the claim, told me that at 20 feet from the bottom the solid reef was cut off by a 1-inch pyrites vein, or fault, but that pyrites and quartz veinlets were followed to the bottom, when work had to be abandoned because of the quantity of water.

In this shaft, 80 feet down, the sandstone gave way to blue-black slate, with shaly beds containing aggregations of pyrites, and it was noticed by the

miners that below the pyrites vein the black slate was soft and slickensided. No information could be obtained as to the lie of the beds, but they probably strike east and west.

Sutton's vertical shaft, half a chain to the east of the main shaft, was begun in 1900 by a company who had to abandon the ground before reaching the reef. The latest proposal is to enlarge the shaft to 9 feet by 3 feet 6 inches, and sink to the reef.

Mr. Skertchley gives the total crushings from the western part of this reef up to March, 1894, as 249½ tons for 413 oz. of gold (valued at £1,294), an average of 1 oz. 19 dwt. per ton.

The eastern worked portion of the reef is separated from the older western by unworked ground, and has probably been slightly faulted by the dyke struck in the No. 1 North workings. They have yielded 10 to 15 dwt. stone, but one crushing from a 9-feet shoot in 18 to 27 inches of quartz gave 1½ oz. per ton. The stone now remaining to a depth of 90 feet is believed to carry only 3 or 4 dwt.

The company who sank Sutton's shaft constructed a small dam on Saw Gully, and erected the five-head steel battery now standing beside it, a quarter of a mile east of the workings.

St. Patrick North.

The St. Patrick reef lies just outside the P.C. claim, 1½ chains north of the older line, and dipping in the same direction. (*See* plan.)

Good results have been obtained from it only east of the cross dyke referred to. In the No. 1 shaft, Mr. Clare informed me, a rich 6-inch leader was followed down to a depth of 25 feet, when it was cut out by an 18-inch reef carrying at most 15 dwt., and averaging only 5 dwt. (In the vertical shaft, 68 feet deep, half a chain to the south, 5 dwt. stone was struck.) The five crushings recorded for 1902 total 61 tons, yielding 110 oz. 17 dwt., and were most probably derived from the leader.

The No. 2 shaft, a chain to the east, struck a reef carrying 5 dwt. at 50 feet depth, but in No. 3 shaft, still further east, the quartz was absent from between the walls.

A 90-feet shaft on the reef just west of the dyke proved 2 feet of quartz, carrying 4 dwt. of gold.

Victoria.

The Victoria, which strikes west by north, is believed to be the western continuation of the St. Patrick, from which the workings are a quarter of a mile distant. The Victoria has been opened in the vicinity of the junction with another reef from the south-east, which consists of 2 feet of quartz with limonite stains on cracks and 18 inches of ironstained quartz dipping 70 degrees to the south-west. Only one parcel (10 tons) has been won since 1865. This was from the branch reef, and it yielded 1 oz. per ton, but the remaining stone is believed to carry no more than a few pennyweights.

The Victoria, at the junction, is about 20 feet across, and Mr. Clare, who has prospected it, believes it to carry an average of 1 dwt. per ton. Five shafts about 2 chains apart were sunk (on separate claims) in the early days to a depth of 60 or 70 feet. Four tons from the paddock of one of these was crushed by Mr. Clare for 17 dwt. The blue-stained quartz is very promising looking, but the gold is said to occur very irregularly in it. Ten chains west of the junction of the reefs the quartz changes to "augen"—quartzite.

This is evidently a big proposition, well worth a proper test.

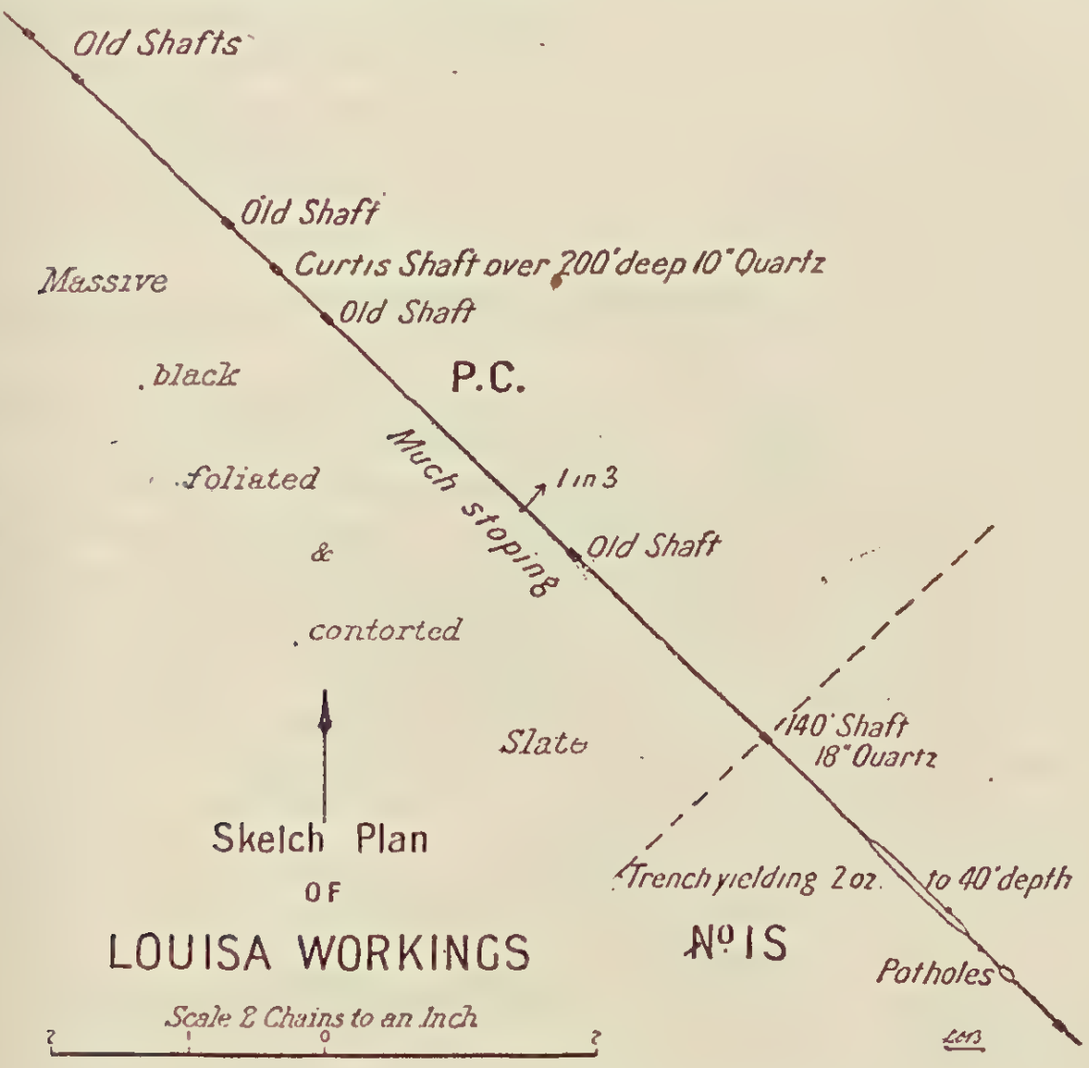
LOUISA CLAIMS.

The Louisa lies 1½ miles north of Pratten, within a quarter of a mile of the Condamine River.

Mr. Skertchley* visited the mine in 1898, and found that, in 1872, 15 tons had been crushed for a yield of 3 dwt. per ton. Other crushings had been obtained at intervals till shortly before his visit, one of the latest giving 1½ oz. per ton, but another scarcely any gold. From Mr. Skertchley's description it would seem that he was unable to actually inspect any of the underground workings.

Mr. Rands† visited the mine in 1900, and refers in his report to two shafts —one on the boundary of the P.C. and the No. 1 South, and the other on the P.C. The former had been deepened, with the aid of a Government subsidy, from 35 to 90 feet, on a 6-inch reef, carrying little or no gold; but it was abandoned shortly afterwards, and another, 330 feet to the north, continued from a depth of 154 feet, on a foot of good stone. A few small lots of ore were obtained during 1902. The only additional crushings are 10½ tons, treated in March, 1903, for a yield of 9 oz. 14 dwt.; this stone was obtained from a shoot on the north-eastern end, but the stone gradually got too poor to pay. Three former crushings from the same place are said to have yielded 1½ oz. per ton, while the stone from the surface at the south-eastern end yielded 2 oz.

A rough sketch plan of the workings is appended, and shows that the reef, which strikes north-west and dips north-east, has been proved by shafts and trenches for a distance of over 10 chains.



* Op. cit. † Annual Report for 1900.

Curtis's underlie shaft (the second referred to by Mr. Rands) was the only one accessible in August. The Curtis Bros. intended to sink the shaft to 300 feet depth to prove the reef, but at a little over 200 feet the water proved too strong to be baled with a truck and whip, and it now stands at about 100 feet depth. The country rock is massive black, foliated, and contorted quartzose slate.

The reef is almost vertical; the walls near the surface are 9 inches apart, but the distance gradually increases, till at the 80-feet level they are 7 feet apart, with 4 feet 6 inches of quartz on the hanging-wall. To the north-west the reef has not been tested, but a drive to the south-east proves it to gradually decrease in width in that direction.

The reef has been stoped above the 70-feet level, and the walls are still standing well. Big crushings are reported to have been obtained from the 70-feet level, and 1 oz. 18 dwt. from the reef below it.

Rich stone was also won in the No. 1 South, as witnessed by the stopes within 2 chains of the P.C.

The reef is known to be very patchy, but that simply necessitates its being worked on a larger scale than heretofore.

Numerous reefs are known to exist between the Louisa and the Malakoff, but they are believed to be very poor.

PRINCE OF WALES.

This mine lies a quarter of a mile north-west of Pratten, and was first opened in 1877. There were abundant very rich "shoads" on the surface. Five shafts, within a total distance of 5 chains, were opened on a rich 6-inch leader dipping east-south-east. Four tons are said to have carried 400 oz. of gold, but the leader pinched out within 30 feet of the surface. The shafts were continued to 70 feet depth, on an 18-inch reef, the gold in which was not sufficient to pay to crush.

In 1902, an unsuccessful attempt was made to prospect the northern end of the reef, colours only being obtained.

The country is quartzose slate somewhat similar to that at the Louisa, and the quartz of the reef appears to have replaced the slate.

The abandoned Sultan and Taylor reefs (reported to vary from 4 to 18 inches in thickness and to carry from 11 dwt. to 7 oz. per ton) were visited, but nothing in addition to what is reported by Mr. Skertchley could be obtained. The mine lies 1¼ miles (not half a mile) distant from the Pratten Post Office.

No attempt was made, in the limited time available, to visit the unworked Malakoff or the abandoned Woodman, Brilliant, and Guiding Star reefs.

Brisbane, 28th October, 1903.

MOUNT STURT AND FREESTONE CREEK IN THE WARWICK DISTRICT.

MOUNT STURT.

Location: In June last, the discovery of gold was made known by a prospector after considerable search in the valley on the northern side of Mount Sturt, which lies 2 miles north-north-west of the township of Yangan (on the Warwick-Killarney line), the rumour being that payable gold could be found throughout a large formation of red rock occurring on both sides of the valley. All the land in the vicinity being freehold, negotiations were at once made with the owners by a syndicate of Killarney people to test the ground.

Geology: Practically the whole of the district between Yangan and Freestone Creek is capped with basalt and the products of its decomposition, but shales, sandstones, and conglomerates outcrop at several places along the Warwick-Killarney Railway Line (the town of Yangan being built on sandstones covered with a residual coat of black soil), and also on portion 773, Robinson, near Freestone Creek, in the north of the area. These sedimentaries are presumed to be of Trias-Jura age, and in several wells they have been found to enclose small seams of coal. The thickness of the basalt varies greatly, and, owing to the uneven surface of the underlying sediments, the base of the volcanic rock on Mount Sturt is several hundred feet above the base near Yangan. The basalt cap has been built up of successive flows, and that considerable intervals sometimes intervened between the eruptions is proved by the occurrence on the road beside portion 1976, Robinson, on the eastern side of Mount Sturt, of petrified wood (now being described by Mr. Shirley, B.Sc.), presumably from between two flows. Laterite, 50 feet or more in thickness, apparently interbedded with basalt, also points to intervals having occurred. This rock forms a broken terrace, 1 to 5 chains wide, round the valley opening into Cooper's Creek, on the northern side of Mount Sturt, and is also found in the bed of Freestone Creek, some miles to the north. The terrace rises abruptly 30 feet, and even 50 feet, above the black-soil flats, and that the rock extends below the flats has been proved in one place. The laterite varies greatly in character, being generally dark-red in colour, with a brecciated structure, but it often resembles burnt earth; or, again, its surface is rough and slaggy, with lumps of only partly decomposed basalt scattered through it. The latter may represent bombs and lapilli (in which case the rock is a decomposed tuff), or simply the harder kernels (and the rock is decomposed basalt). On the whole, the evidence is in favour of the former hypothesis. In the only place where sunk on for any depth the earthy red limonite has been proved to pass into a soft grey kaolinised material containing large quantities of a bright silky golden-yellow limonite (hydrated sesqui-oxide of iron), surrounded by a thin coating of a dense and dark-brown form of the same mineral. It has much the appearance of gold, but the fact that it does not form a tail in the dish when panned off should be sufficient proof for prospectors that it is not gold.

It is in the laterite that the gold has been believed to exist, and the prospector (who was not able to be present during my visit) is reported to be able at certain places to get colours almost without fail. Several of the local residents have at different spots picked up specimens either showing free gold or yielding it on crushing, but they acknowledge that in all cases further search has not revealed the presence of additional gold. One specimen containing a speck of gold was shown me. A sample taken from the roadway at the western side of portion 1909, one of the places where specks of gold have been found, yields (Government Analyst)—

Gold, trace; silver, 2 dwt. per ton.

While it is not impossible for the gold to have been actually concentrated from the laterite during its decomposition, it is more feasible to assume that the metal has been shed from a former creek bed at a greater elevation.

Portion 14v, Robinson.

Gold was first reported from this property. A shaft had, at the time of my visit, been sunk near the centre to a depth of 35 feet, and in it the usual red surface laterite changes at 25 feet to a brownish-grey kaolinised material, with white spots having the shape of amygdules; at 30 feet depth is a further change to blue-grey, and at 35 feet to grey. Throughout the greyish material are specks and grains of bright yellow silky limonite, having a strong resemblance to gold. Mr. Carmody, who owns the land, and is sinking the shaft, informed me that he found a few specks of gold at a depth of 6 feet, but had been unable to find a trace since. A sample from the heap of material on the surface assayed by the Government Analyst yielded—

Gold, trace; silver, 4 dwt. (approximate) per ton.

About 6 feet above the level of the brace of Carmody's shaft, and a few yards west of it, is an outcrop of massive turgite (slightly hydrated sesquioxide of iron) and limonite. It appears to be a bed 12 to 18 inches thick, and has been traced for 3 chains to the north, but to the west is covered by basalt within a few yards. The iron has probably been leached out of the decomposing basalt. Another outcrop of similar iron ore is seen in the southern corner of subdivision 2, portion 2155.

Portions 16v and 2155, Robinson.

The Killarney Syndicate, being unable to secure portion 14v, tried the laterite across the valley, half a mile to the north-east. A considerable amount of the face of the terrace has there been blasted off, and 4 tons from the two above adjoining portions were lately crushed at Aldershot, but the return has not been published.

A number of samples both of the whole of the face of the terrace and of the ironstone veinlets were dollied and washed by members of the syndicate, by various local people, and by me, without finding a colour of gold. A sample of the stone broken down on portion 2155 yields (Government Analyst)—

Gold, trace; silver, trace;

while a sample from portion 16v yields (Government Analyst)—

Gold, trace; silver, 1 dwt. 10 gr. per ton.

There certainly is a large amount of rock here, possibly 70 or 100 feet in thickness, and covering many acres, but, as my samples have not yielded more than a trace of gold, I cannot consider it payable.

The situation is a splendid one for quarrying operations, the rock rising to 50 feet above the flats, which themselves are 50 feet above the creek bed. The proximity to a railway line would also count in its favour.

FREESTONE.

Following the announcements from Mount Sturt, an exposure of laterite in the bed of Freestone Creek, north of portion 1146, Robinson, was secured by the Red Rock Syndicate, and held by them till a few months ago, but no work was done on the property. The laterite here is at least 20 feet in thickness, and has undecomposed basalt both above and below it. A general sample taken by me from the whole of the outcrop, about a chain in width and 15 chains along the creek, yields—

Gold, a trace; silver, 2 dwt. per ton.

Another outcrop of laterite is to be seen on the western side of portion 773, a few chains south of the road, but a sample from it does not yield a trace of gold. This is covered to the east by basalt, which nearer the homestead on the portion gives way to conglomerate and sandstone, apparently an "inlier" or island of the coal measures. Scattered lumps of jasperoid have been found on the surface here, some of which are said to carry gold; they have probably been derived from the conglomerate, and no hope can be held out of a workable lode being found. The conglomerate itself may, of course, be yet proved to carry alluvial gold.

In August last, a claim was taken up on Mount Dumaresque, portion 2v, Gladfield, 4 miles west-north-west of the Red Rock lease, but it was not visited, as it was believed to have been abandoned.

CONCLUSION.

From the above, it will be seen that nothing payable has yet been proved either at Mount Sturt or at Freestone. The discovery of gold in laterite, a new condition for the occurrence of the metal, would be most interesting from a geological point of view. There is more likelihood of gold being found in the old bone-bearing stream beds beneath the basalt, but they do not seem to have ever been tested, though several wells in the district have been sunk on them; owing, however, to the bed rock being unaltered Trias-Jura sediments, which have nowhere yet in Queensland been proved to be auriferous, there is no promise of rich auriferous deposits being found here, even in the old stream beds.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

NATIONAL MUSEUM VICTORIA

Queensland.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY REPORT,
No. 188.

WOLFRAM AND MOLYBDENITE MINING IN QUEENSLAND.

BY

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ASSISTANT GOVERNMENT GEOLOGIST.

CONTENTS:

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BRISBANE:

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1904.

WOLFRAM AND MOLYBDENITE MINING IN QUEENSLAND.

I.—HISTORICAL AND STATISTICAL.

Mining for the minerals wolfram and molybdenite has of late years assumed some degree of importance in Queensland, on account of their having recently come into more extended use in the arts, and from their occurring in considerable abundance in several localities in the northern part of the State.

Wolfram was first found in payable quantities in 1894 on the Hodgkinson Gold Field, at a place now known as Wolfram Camp. Sixty-five tons were sold during the year, and realised about £650. Subsequently the mineral has also been mined in some quantity at Lappa, near Petford Siding, on the Chillagoe Railway Line, on the same goldfield. Other small parcels have been obtained at Tinaroo, near Mareeba, at Coolgarra, on the Herberton Tin Field, at Port Douglas, the Kangaroo Hills mineral field, and at Noble Island, 100 miles north of Cooktown. The mines at Wolfram Camp and Lappa have, however, furnished the great bulk of the Queensland supply, and are still being worked. Their record up to the end of 1903 has been 860 tons, of a value on the field of £28,578. The average value of the ore on the field up to the present time thus works out to about £33 4s. per ton.

At Wolfram Camp and Lappa the mineral was found scattered over the ground in waterworn pebbles and boulders, and in smaller grains in the sand of the water-courses and creeks. For the first few years the production was very small. In 1895, 21 tons were sold for £462, but for 1896 there is no return recorded. In 1897, 13 tons brought £195, and in 1898, 68 tons brought £2,040, an average of £30 per ton. In 1899, when the price of the mineral was at its highest, 240 tons were obtained, and realised on the field £9,120, or an average of £38 per ton. Owing to the exhaustion of the more readily obtained surface stone, and the necessity for mining for most of the ore in order to maintain the supply, the production during the next year fell to 188 tons, of an average value of £35 per ton. A heavy fall in the value of the mineral at the end of this year led to a great reduction of the output for the next two years, many of the miners turning their attention more particularly to molybdenite, which had then lately come into good demand. The prices obtained during these two years averaged about £18 per ton, at which figure the mining of the mineral as it occurs in most of the lodes on the Hodgkinson, leaves little margin for profit.

During the early part of 1903, the price increased again rapidly, till it stood at about £30 per ton for clean ore on the field at the end of June. This fact, coupled with the break-up of the drought and consequent amelioration of the conditions of living on the field, led to a revival of mining, the lodes at Lappa now also receiving considerable attention. By September the price had risen to £45 per ton, and the number of miners employed in working wolfram had increased to 150. The return for the year was 138 tons, of a value of £7,251, an average of £52 per ton. By the end of the year the miners were receiving £56 per ton at Wolfram Camp, and £58 per ton at Lappa. Such

prices make the mining of wolfram on the Hodgkinson lodes a highly profitable industry, and if maintained for any time, bid fair to make these localities very important mining centres.

The mineral molybdenite had been found associated with wolfram in increasingly large quantities in the lodes at Wolfram Camp, as these were sunk on below the surface. No market, however, could be found for the mineral till the year 1900, when a visit from a representative of an English ore-buying firm led to the first sale, the mineral having only a short time previously come into good demand. In 1900 the field produced 11 tons of clean mineral, for which £51 was received. The value of the ore rose rapidly, till, at the end of 1902, it fetched £200 a ton on the field. The output increased to 26 tons in 1901, and 38 tons in 1902. Most of this ore came from a few lodes within a circumscribed area at Jeff's Camp, Wolfram Camp, but other lodes also gave small quantities. During the early part of 1903, the price suddenly fell to £120 per ton, and remained at about that price during the greater part of the year. The output for the year was about 10 tons, for which £1,321 was received, giving an average value of about £132 per ton.

Mr. Ball reports the occurrence of molybdenite in the Chowey reefs, Degilbo; in the reefs of the Perry Scrub, and of Mudloo Valley, Kilkivan district; on the Maxwellton Gold Field; and on Blue Mountain Creek, Stanthorpe. A few hundredweight of ore have been sent away from the last-mentioned place.

The accompanying table, compiled from the annual reports of the Mines Department, gives the amounts and values of wolfram and molybdenite ore produced to the end of 1903 in Queensland:—

AMOUNTS AND VALUE OF WOLFRAM MINED AND SOLD IN QUEENSLAND TO END OF 1903.

Year.	Hodgkinson.		Port Douglas.		Kangaroo Hills.		Herberton.		Ravenswood and Star.		Cooktown.	
	Tons.	£	Tons.	£	Tons.	£	Tons.	£	Tons.	£	Tons.	£
1894 ...	65	650	40	60	...	...	...	...	...	...	...	...
1895 ...	21	462	4	80	...	...	...	...	...	...	...	...
1896 ...	..	...	....	...	3	60	...	...	...	...	...	...
1897 ...	13	195	...	...	...	...	...	...	...	...	...	..
1898 ...	*68	2,040	10	500	10	500	...	...	...	...	...	...
1899 ...	240	9,120	2	90	...	...	...	...	17	850	...	...
1900 ...	188	6,550	...	...	...	...	0½	35	...	...	1	20
1901 ...	72	1,145	...	...	...	...	...	...	...	...	...	...
1902 ...	55	1,165	...	...	...	...	...	...	...	...	...	...
1903 ...	138	7,251	...	...	...	..	..	...	...	...	...	...
Total ...	860	28,578	56	730	13	560	0½	35	17	850	1	20

* Entered in the Mines Department reports to Herberton.

AMOUNT AND VALUE OF MOLYBDENITE MINED IN QUEENSLAND TO END OF 1903, HODGKINSON GOLD FIELD.

Year.	Tons.	Value.
		£
1900	11	561
1901	26	1,609
1902	38	5,329
1903	11	1,321
Total	85	8,820

II.—TECHNOLOGY.

The demand for wolfram and molybdenite is small and irregular, and is easily over-supplied by an increase of production. The prices accordingly fluctuate greatly as the supply falls short of or overtakes the demand. It is consequently impossible to get quotations of prices in the home markets except for *bonâ fide* offers on the spot. The purchasing of these ores, therefore, on the Queensland fields, and the shipping of them to England for sale, is somewhat of a speculative business, the prices being liable to fall or rise considerably before the market can be reached. The increased demand of late years has sprung from the employment of both minerals in the manufacture of special classes of steel, each mineral imparting its own particular property to that metal.

Wolfram.—The useful ingredient in wolfram is the metal tungsten, generally estimated as tungstic acid (the mineral being a tungstate of iron and manganese). The pure mineral contains from 73 to 76 per cent. of tungstic acid. The commercial ore, owing to admixture of quartz, which cannot all be easily separated by hand dressing, rarely contains over 70 per cent., but should not contain less than 60 per cent. The price of the ore is based on the ruling rate for 60 per cent. ore, plus an additional sum for every unit of tungstic acid above 60.

Tungsten, when added to steel in small proportions, renders it particularly hard, and also self-tempering. Tungsten steel is, therefore, used in the manufacture of certain edged tools, and in the wearing parts of machines. Tungstic acid compounds are also used for rendering colours fast in cotton fabrics, and for making dress materials and curtains uninflammable for theatrical purposes.

According to the "Mineral Industry" for 1902, the production of tungsten metal in the United States during 1902 amounted to 82,000 lb., as compared with 13,000 lb. for 1901; ferro-tungsten, 14,000 lb., as compared with 13,000 lb. in 1901; and tungstic acid and tungsten salts, 3,500 lb., as compared with 3,000 lb. in 1901. The prices varied from 58 cents to 64 cents per pound for tungsten metal, and from 27 cents to 31 cents for ferro-tungsten, the prices being practically the same as for the preceding year. The prices of ore varied from about 2 dollars per unit for 45 to 55 per cent. ore, to 4 dollars and a-half for 55 to 65 per cent. ore.

Wolfram is a dark greyish, or brownish black, mineral, with submetallic lustre, and gives a reddish brown powder. It cleaves readily into plates. It is heavy (specific gravity, between 7 and 8). It resembles magnetite, but can be distinguished by its having only one cleavage, and by the colour of its powder, magnetite having four cleavages and giving a black powder. It is non-magnetic, but is easily fusible before the blowpipe, when it becomes magnetic.

Molybdenite.—Molybdenite is a compound of sulphur with the rare metal, molybdenum, and when pure contains 60 per cent. of the metal. Consumers require an ore containing at least 45 per cent. An alloy of the metal with iron is first made, containing about 50 per cent. of molybdenum. The sulphur is got rid of by roasting the mineral, or treating it with nitric acid, thus leaving the oxide of molybdenum. This is then fused in an electric furnace with carbon, and a carbide of molybdenum formed, which, on fusion with molten iron, gives ferro-molybdenum. This alloy, when added to steel in certain small proportions, gives molybdenum steel. It is also added in still smaller proportions to nickel-steel and chrome-nickel steels. These steels contain from .25 to 4 per cent. of molybdenum, by the addition of which their toughness

and elasticity are greatly increased. They are used chiefly for forgings of all kinds, such as gun and rifle barrels, boiler-plates and shells, also for large crank and propeller shafts, and for armour-plates for war vessels.

The "Mineral Industry" for 1902 says:—"The demand for molybdenum has largely increased within recent years, due to the property possessed by the metal of rendering chrome steel self-hardening. It is claimed that the self-hardening property can be imparted to chrome steel by the addition of one half of the quantity of molybdenum, as compared with tungsten."

During 1903 ferro-molybdenum, containing 50 per cent. molybdenum, was quoted regularly in the United States at 1 dollar 25 cents per pound.

The production during 1902 amounted to 35,000 lb. of molybdenum metal, and 16,000 lb. of ferro-molybdenum, the price for the metal varying from 1 dollar 55 cents to 2 dollars per pound. A great portion of this was made from ores obtained from abroad, as only about 12 tons of ore were produced in the country. The value of ore containing between 50 and 55 per cent. molybdenite was about 300 dollars per ton during 1902.

The mineral molybdenite is also used in small quantities for the manufacture of blue carmine, a colour used for painting on porcelain.

Molybdenite is a lustrous, lead-grey mineral, occurring in large masses or smaller plates. It breaks up readily into innumerable thin flakes, which are very soft and flexible, but not elastic. Molybdenite will leave a grey mark on paper, and, when heated over a flame in an open tube, gives off sulphurous fumes. It resembles graphite, but is paler in colour, and is distinguished by its action on heating in a closed tube.

The use of these minerals in steel-making has gone beyond the experimental stage, and seems to be on a firmly-established basis as a recognised method of improving its quality for special purposes. The demand for the minerals accordingly seems likely to remain constant as long as they can be supplied at a reasonable cost, so that it is not necessary to look about for substitutes. As they are used only in very small percentage, their addition does not add greatly to the expense of manufacturing steel even at present prices, which are highly remunerative to the producer. The demand may thus be expected to increase as the steels in which they are used become better known. Since, however, the minerals are only used in small proportion in these steels, which, again, are only suited to a comparatively few purposes, it does not seem likely that this increase will be sufficiently rapid or sufficiently large to long outrun the supply for some years to come. This is especially true in the case of wolfram, which is much more abundant than molybdenite. There seems every prospect, however, of a continuous demand for both these minerals at prices which will stimulate work on the North Queensland lodes for some time.

III.—GEOLOGY.

On the Hodgkinson Gold Field wolfram and molybdenite frequently occur together in the same lode. The former is, however, much the more abundant mineral, many of the lodes containing only small quantities of the latter. The lodes at Wolfram Camp, in fact, are the only ones in which molybdenite has been found in payable quantities, and there only in a few of the lodes. The gangue is a clean white quartz, often clear and glassy, occupying the joints and contraction fractures of a grey biotite granite. Associated with the wolfram and molybdenite is a considerable quantity of metallic bismuth, which is

also saved and sold. In the lower levels of some of the deeper mines arsenical and iron pyrites are met with. The wolfram and molybdenite occur in large masses scattered through the quartz gangue, the greater portion being easily separated by hand-dressing with a knapping hammer.

In a number of cases the outcrops of quartz occur at intervals along a fairly well defined line, but are of workable size and richness only at detached points. There is never a well-defined and continuous lode with distinct walls of cleavage between the quartz and the granite. In many cases the lode consists of granite veined through with mineral-bearing quartz; in others the quartz occurs in vertical or horizontal veins irregularly distributed through the granite, and seldom continuing of the same thickness for any great distance.

The majority of the rich wolfram-producing claims at the Top Camp, Wolfram Camp, lie along a fairly continuous line of lode. The granite rock here, as shown by the exposures in the numerous shafts and open-cuts, is traversed by numerous contraction cracks, lying roughly parallel to each other and to the surface of the ground. This occurrence gives the granite the appearance of being stratified, and has no doubt been caused by the shrinking of the granite as it cooled and solidified from a molten mass. In many of the claims the quartz of the lodes, on being followed down by vertical shafts for a few feet, has "cut out" on a floor of granite, along which it spread in a horizontal direction. These horizontal veins, on being excavated by mining after the manner in which a horizontal coal seam is mined, are seen to lie parallel to the contraction cracks of the granite, along one of which they have apparently been formed. The horizontal veins do not generally extend to any great distance laterally from the line of lode, being confined as a rule to within a short distance on either side of it. They vary greatly in thickness, and, as the granite is broken across by numerous vertically disposed cross-joints, they are very irregular in their course. The vertically disposed cross-joints also frequently contain seams of quartz and mineral. The thickness of these seams of ore is never much more than 10 or 12 inches. Some of the vertical standing main lodes, however, open out into large bodies 3 and 4 feet in thickness, but do not generally continue at that thickness for more than a few yards.

In a great many cases the quartz of these vertically standing main lodes has apparently been formed along a main joint plane of the granite, and in these cases it is often of considerable thickness, and forms a more or less well-defined lode running for some distance. The smaller, but often much richer, horizontally disposed veins seem to be in most cases off-shoots from these lodes along the main joints. Although they have been found to make into large bodies, and again pinch out into almost nothing within very short distances, these main lodes, with their occurrence of ore at numerous points along a considerable length, encourage the hope that on being followed down they will lead to other deposits at greater depths.

In the more distinctly molybdenite-bearing lodes at Jeff's Camp, the outcrops consisted of "blows," or roughly circular or oval-shaped outcrops of quartz carrying wolfram and bismuth. Molybdenite did not generally make its appearance within the first 10 or 12 feet from the surface. On being followed down by shafts these outcrops developed into irregular pipe-shaped bodies surrounded on all sides by granite, being at times almost vertical and at others dipping flatly. All the quartz was taken out in the circumference of the sinking, granite being left on every side. The quartz graduated rapidly into the granite with no marked plane of division, and both quartz and mineral were often found extending as veins into the granite for some few inches or a foot from the main mass of the quartz.

The jointing of the granite has apparently been the determining factor in the form taken by these lodes, the main joints having allowed of the entrance of siliceous and mineral-bearing solutions from below, which have spread into the surrounding contraction cracks and fissures. The granite walls of the joints have been subjected to considerable alteration at detached points along their length, with a correspondingly great or slight deposition of quartz and mineral. The pipe-like character of many of the lodes is difficult to account for, but may possibly be due to the formation of a more or less vertically disposed conduit for the mineralising solutions along the junction of intersecting joints.

In the majority of the lodes the deposition of the ore has been most abundant along the horizontal contraction cracks, that along the vertical planes merely serving to lead the miner down to more important deposits of the former character below. It seems, therefore, reasonable to suppose that other horizontal seams lying parallel to those above should be found by further sinking, and apparently there is no reason why the depth should be very great, as the contraction planes are closely set together. The deposits are not as a rule of sufficient value to warrant any great outlay in dead work in looking for further deposits, but any sign of quartz going down should be worth following in the hope of striking other deposits of value, occupying lower contraction seams in the granite.

IV.—WOLFRAM CAMP LODES.

Wolfram Camp lies about 14 miles west by north of Dimbulah, a station on the Chillagoe Railway Line, 47 miles from the port of Cairns. A good road from Dimbulah crosses the Walsh immediately north of the railway station, and follows down the right bank for about 9 miles. It then strikes north up the Valley of Four-mile Creek, on which Wolfram Camp lies about 4 miles above its junction with the river.

Jeff's Camp Workings.

These workings lie about half a mile up the creek from the main camp in a tributary gully. A number of claims in this locality are being worked mainly for molybdenite, being all contiguous to one another. The first met with is—

Shaw's Claim.—This claim was worked on the surface for bismuth, and the quartz followed down in a flatly inclined shaft to a vertical depth of 20 feet. A vertical shaft was then sunk to strike the bottom, and the underlie continued on the ore body at the old grade. There is a little quartz showing here and there down the underlie, but practically the whole of it has been removed in the sinking, the greatest diameter of the pipe of ore being less than 6 feet. About 10 feet below the vertical shaft the first molybdenite was struck, and it has continued down another 30 feet to the bottom. The bottom is a mass of white quartz surrounded on all sides by granite, and splashed through with large masses of molybdenite. This was the only mine from which molybdenite was being obtained at the time of my visit.

From six to seven tons of clean molybdenite were obtained from the last 30 feet of the shaft. As the ore brought latterly from £100 to £200 per ton, it will be seen that this has been a very profitable mine, especially as it gave very little trouble in the cleaning of the ore. The molybdenite does not seem to come to the surface in any of these mines, owing, probably, to its weathering easily under atmospheric influences. It generally first makes its appearance at from 20 feet to 30 feet below the surface. The wolfram and metallic

bismuth, on the other hand, are found with little alteration right at the surface, and occur together in the surface soil, where much of the latter is in the form of carbonate.

In dressing the ore the larger lumps of molybdenite are broken off from the attached quartz by hammer, washed, and put aside for bagging. The finer stuff is screened through ½-inch screens, and that remaining on the screen roughly jigged in water. The heavier lumps of molybdenite collect at the bottom of the screen, but the more flaky material, owing to its buoyancy in water, cannot be separated from lighter quartz gangue: and, as there is little sale for anything but clean mineral, a great deal of it is at present wasted. The fines from the first screening are afterwards treated on ⅛-inch and $\frac{1}{16}$-inch screens, and the less flaky portions of the mineral thus saved.

Kenrick's Claim.—This claim lies immediately to the north of Shaw's claim, and adjoins it. The first molybdenite sold from the field was obtained from this claim in 1900. The shaft has been abandoned, as has also a second, sunk on another lode some 60 feet south of it. Both underlay flatly to the north, and were sunk to a vertical depth of about 40 feet. About 12 tons of molybdenite were obtained from the two. A third lode, some 30 feet behind the second, was being worked at the time of my visit. The shaft was sunk first 16 feet vertically on an outcrop of quartz carrying bismuth, which was then followed on the underlie for about 20 feet. The first bunch of molybdenite was struck here, and about 1½ tons obtained in a few feet. The shaft at the time of my visit was full of water to this point. About 5 feet further down, the pipe of quartz turned over vertical, and another patch of ore was followed down for about 10 feet. About 2 tons of clean mineral were obtained from here. The flooding of the shaft during the wet season of January, 1903, prevented further work, and, owing to the inconvenience of bailing, a vertical shaft was being sunk from the surface to strike above the second bunch of ore.

The ore here occurs less in the body of the quartz, and is disseminated more freely through the immediately surrounding granite. This involves greater trouble in obtaining clean mineral for sale, the majority of it having to be broken up fine by a hammer, and repeatedly jigged through screens. This entails considerable expense and waste of the finer portions of the mineral. Mr. Kenrick estimates that it has cost him £30 a ton to clean the ore obtained from this shaft.

There is great need of a cheap and effective machine to save the finer and more flaky portions of this mineral. The specific gravity is about 4.6, as compared with 2.65 for quartz, but the buoyancy of the flakes of molybdenite in water is little, if anything, less than that of quartz of the same diameter. To crush the material by stamps would only accentuate the difficulty. Possibly, if crushed by means of rolls, the quartz would be reduced to a fine state, while the flakes of molybdenite would suffer less comminution than if crushed under stamps, and could consequently be separated from the fine quartz by some form of settling-box. There is not, however, sufficient of this class of ore on the field, nor sufficient demand for the mineral, to warrant the employment of very expensive machinery.

Gillian's Claim.—This claim adjoins Kenrick's claim on the west. A large quantity of wolfram and some bismuth were obtained from a lode striking north and south in open-cut workings, extending for some 2 chains in length and 12 or 14 feet in depth. The lode is seen on the southern end of these workings in about 4 feet of quartz and country rock, the quartz ramifying through the granite in solid veins, and being splashed through with masses of wolfram. The shoot of ore was found to be dipping to the north, and is said

to have carried molybdenite at this end, where it crosses a watercourse draining into the main creek. A shaft was being sunk on the other side of the creek to catch the lode, and was reported to have broken into molybdenite as I left the field.

Burke and Jennings' Claim.—This claim lies immediately to the east of Kenrick's claim. The shaft dipped to the north at a flat angle, and had given about 2 tons of clean mineral. It was full of water. A vertical shaft was being sunk about 36 feet further north, to catch the old workings, and thus facilitate bailing.

Top Camp Workings.

In this neighbourhood many of the workings extend along an east and west line for a distance of about 20 chains, lying at the northern base of a hill. The main products have been wolfram and bismuth. The first claim at the southern end is—

Nicholl's Claim.—Here a shaft was sunk on quartz and wolfram for about 20 feet, when it suddenly cut out on a floor of granite. An open cut was then driven in from lower down the slope, to cut the bottom of the shaft, and was continued in to the east along a flat seam of ore for about 20 feet. The lode then dipped down to the north, and was taken out in a wide excavation under the granite. The lode in the face shows about 3 feet of quartz splashed through with large lumps of wolfram, lying with a gentle dip towards the fall of the hill along a more or less horizontal seam in the granite.

Carroll's Claim.—In this claim a shaft was sunk vertically on the hill side a depth of 20 feet. It first followed a small vein of quartz, which opened out into a large, irregular body carrying good wolfram. This body of ore cut out almost completely below, leaving only a thin vein of quartz, which was subsequently followed vertically for another 20 feet, without any success. About 9 tons of wolfram and 5 cwt. of clean bismuth were obtained from the shaft. A drive was then put in to the east on a horizontally-lying seam of ore, with a slight dip to the north, and this was followed for about 30 feet, and good wolfram and bismuth were obtained till near the end. The ore was all taken out in the width of the drive, leaving nothing of backs or underfoot in the drive.

Larkin's and Weston's Claims.—These two claims are contiguous to each other, and work the same lode, having broken into each other below ground. An underlie shaft on the latter claim, the more easterly of the two, near its boundary with Larkin's claim, followed down a lode of white quartz for about 60 feet, from which were obtained 3½ tons of molybdenite, 9 tons of wolfram, and 7 cwt. of metallic bismuth. A vertical shaft on Larkin's claim, just across the boundary, met the same lode in 27 feet, and was continued to 78 feet, breaking through into Weston's workings. The large white quartz lode can still be seen down the western end of the shaft. A drive from the bottom was put in 20 feet on good ore, and a rise from the end followed good ore up another 20 feet to where it is still seen rich in molybdenite at the top of the rise. A vertical shaft is being sunk from the surface to meet this rise. About 19 tons of wolfram, 8 tons of molybdenite, and 4 cwt. of metallic bismuth were obtained from these workings.

The ore deposits described above are all on an east and west line, and are apparently connected, though there is no well-defined, continuous lode. Mineral-bearing waters have apparently obtained access into the granite, probably by means of a joint plane along this line, and have spread out and deposited mineral along horizontal planes wherever an opening has been left them by the contraction of the shrinking granite mass.

Baker's Claim.—This claim lies about 100 yards beyond Weston's claim, near the base of the same hill, but it is a little south of the line of the old workings. An open cut from the side of the hill exposes a flat dipping seam of quartz, with wolfram showing scattered through it. A shaft was sunk to a depth of 23 feet, and the ore stoped out for a few feet to the west of it. The open cut has been continued some 15 feet further north-west along the lode. The granite above shows the same signs of parting along planes roughly parallel to the surface of the ground, and the lode evidently occupies one of the fissures thus caused. About 15 tons of wolfram and 15 cwt. of metallic bismuth were obtained from the shaft and open cut.

McGuire's Claim.—This claim lies about 300 yards south of Baker's, on the eastern slope of the hill. A flat underlie shaft was sunk on an outcrop of quartz dipping in a northerly direction for about 40 feet, and it still shows ore on either side. Near the bottom of the underlie a shoot of good ore was followed off to the right, dipping steeply with the fall of the hill, and an open cut was brought in from lower down the hill to meet it. At present, the underlie is being sunk further, and shows about 3 feet of quartz and wolfram on every side. The character of the lode is similar to those noticed before, but it appears to be persistent over a much wider area, and there seems every indication that further development will lead to the exposure of additional quantities of ore.

Fletcher's Claim.—This claim is about 400 yards south of McGuire's claim, on the same fall of the hill. Bismuth, associated with quartz, was found on the outcrop, and, on being sunk on, led off to the north in a flat vein of quartz carrying wolfram, the whole of which was taken out in the width of the drive. About 4 tons were obtained in 30 feet of driving, when the ore led off to the west, and was followed in for about 20 feet. A vertical shaft 30 feet deep was sunk from higher up the hill, to meet this drive. All the stone was taken out in the width of the drive, which now shows about 18 inches in thickness in the roof, lying flatly across it, and heavy with wolfram. There is no sign of any vein of quartz going down underfoot.

James' Hill.—At this place a great deal of wolfram and bismuth have been obtained, but at the time of my visit the shafts were full of water. This was being used to dress heaps of old headings on the surface, containing wolfram and bismuth.

Kelly's Claim.—This was the premier molybdenite claim on the field, but it is now full of water and under exemption. The lode was followed down on a flat underlie to the north-east for about 120 feet, and was met by a vertical shaft, 40 feet deep, and short drive at the 100-feet level. The claim lies on the top of a hill between the main camp and Top Camp workings, and across the creek from either. It has furnished about 20 tons of clean molybdenite, 20 tons of wolfram, and 2 tons of bismuth, and in addition about 6 tons of molybdenite seconds. There are on the ground about 10 tons of headings, which it would pay to put through if cheap and effective means could be devised to treat them. This claim was characterised by having a considerable quantity of arsenical pyrites mixed with the ore, and the headings above-mentioned are very pyritic. At one time about 20 men were employed on the mine.

V.—LAPPA LAPPA (PETFORD) LODES.

The mines at this place lie about 16 miles due south of Wolfram Camp, and are from 2 to 4 miles from Petford Siding, on the Chillagoe Railway Line. The lodes resemble in character those at Wolfram Camp, but as yet have

not given any payable deposits of molybdenite. They stretch along a strip of country about 2 miles in length, striking in a south-westerly direction from the hut at the crossing of the main western road over Emu Creek to a point about a mile north of the old Oakvale Hotel, on Oakey Creek. At the south-western end is—

Enright's Claim.—Here a hole had been put down about 12 feet deep on portion of a large "blow" of white quartz, which carried wolfram at this point.

Bemi's Claim, on the brow of a hill facing to the north, showed a shaft 25 feet deep, on a steeply-dipping vein of quartz, which had given from 5 to 6 tons of molybdenite and 30 lb. of bismuth.

The remaining claims lie further to the east, running over the crest of a hill, which stands out prominently to the north when viewed from the railway line across the flat country between the mines and the line.

The Morning Star Claim is on the southern face of the hill, the workings being visible from the line. The outcrop of white quartz runs for some 20 yards in an east and west direction. Two opencuts at the eastern end, and a shallow shaft at the western, on the southern side of the outcrop, exposed veins of quartz, occupying irregular fissures in the granite. These veins are apparently offshoots from the main quartz outcrop which the workings have not reached, and which is apparently barren of material. About 30 tons of wolfram and half a ton of bismuth have been obtained from these workings.

Knox's Claim.—This claim lies at the very summit of the hill above the camp. The owners have followed an almost horizontal vein of quartz into the hill by means of an open cut, and latterly by tunnelling. The seam has proved very rich in wolfram.

On the eastern slope of the hill are a long line of workings, which have been worked mainly to shallow depths by open-cuts into and along the lodes. On

Dickson and Hansen's Claim a large lode of quartz and wolfram has been sunk on to a depth of 25 feet by an irregular shaft. A vertical shaft close by was sunk to a depth of 40 feet, and a short drive met the lode in a few feet. The lode here did not show much ore, but higher up proved very productive. Further along are a number of workings on the same line of lode, but they were not being worked at the time of my visit. The lode along this portion is large, and looks permanent, and should be able to furnish large quantities of ore in the future.

VI.—TINAROO LODES.

Two five-acre leases have been taken up for these minerals on the head-waters of Tinaroo Creek, about 14 miles south-south-east of Mareeba. Very little work has been done on them.

The country rock is a biotite granite, in places carrying large porphyritic crystals of felspar.

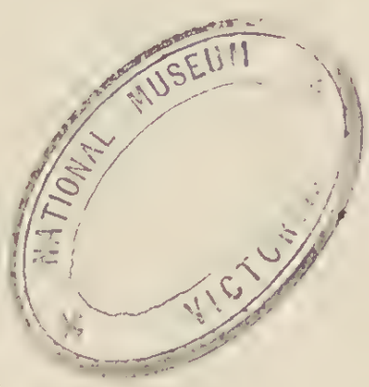
The wolfram lode occurs on Lease No. 1,988, and has been traced by various trenches and shafts for a distance of about 10 chains. The reef, where exposed, varies from 1 foot to 4 feet in thickness, and stands vertically as a well-defined vein of white quartz, with well-marked boundaries of cleavage between itself and the granite. It is apparently a very persistent and regular reef. It carries wolfram at all the points at which it has been opened up, but not always in sufficient quantity to be payable. The lease stretches north-east along the northern bank of one head of Tinaroo Creek. A pit near the southern

corner of the lease on the south side of the creek exposes about 2 feet of white quartz carrying wolfram splashed through it here and there. About 4 chains further north-east on the other side of the creek an open cut into the upper portion of the steep bank exposes about 3 feet of quartz, carrying wolfram freely in irregular lumps up to 6 inches in diameter. There is also here a little molybdenite and traces of bismuth and copper carbonates. This is the best-looking portion of the lode exposed so far, and should be well worth developing. The ore could be conveyed to the creek below, after hand-picking, and then cleaned by stamping and jigging with little expense.

The reef can be traced for about another 6 chains across to the other side of the creek, which here bends to the north. An open cut on one side of the creek, and a shaft on the further side about 3 chains beyond the creek, both expose a strong reef. The shaft is down about 10 feet, and shows the reef about 1 foot in thickness. From the knapped stones on the surface there was evidently a considerable amount of wolfram taken from here.

The lode on Lease 1,989 strikes across the line of the former in an east-south-east and west-north-west direction, and can be traced along the bed of a rocky watercourse for about 3 chains. The lode is of white quartz, apparently occurring along a joint fissure. A shaft has been sunk to a depth of 6 feet in the bed of the watercourse, on a shoot of molybdenite-bearing stone. The shaft was full of water, and could not be inspected. A small quantity of molybdenite was mined, dressed, and removed, but the advent of the wet season prevented further work.

Brisbane, 28th January, 1904.



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REPORT.

SOME MANGANESE DEPOSITS

IN THE

GINGIN, DEGILBO, AND WARWICK DISTRICTS.

BY

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BRISBANE:

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1904.

SOME MANGANESE DEPOSITS IN THE GINGIN, DEGILBO, AND WARWICK DISTRICTS.

This work was carried out as part of the general scheme of having all the deposits of manganese ore in Queensland inspected and reported on as time permitted. Some of the deposits are acknowledged to be poor, but it is hoped that at some time in the future they may be worked, in order to supply Australian iron furnaces with the necessary manganese ore. The only local demand of any extent at present is that of Mount Morgan, where about a thousand tons a year are consumed in the chlorination process. The management now stipulates that no ore containing less than 70 per cent. available dioxide will be accepted—probably because a sufficient quantity of ore of that grade can be obtained from Mount Miller, near Gladstone. The price paid during 1902 was 1s. 1.3d. per unit, on a basis of 70 per cent., with 1s. 6d. per unit in excess. Ore carrying 70 per cent. available manganese dioxide would thus bring £3 17s. 6d., delivered at Rockhampton.

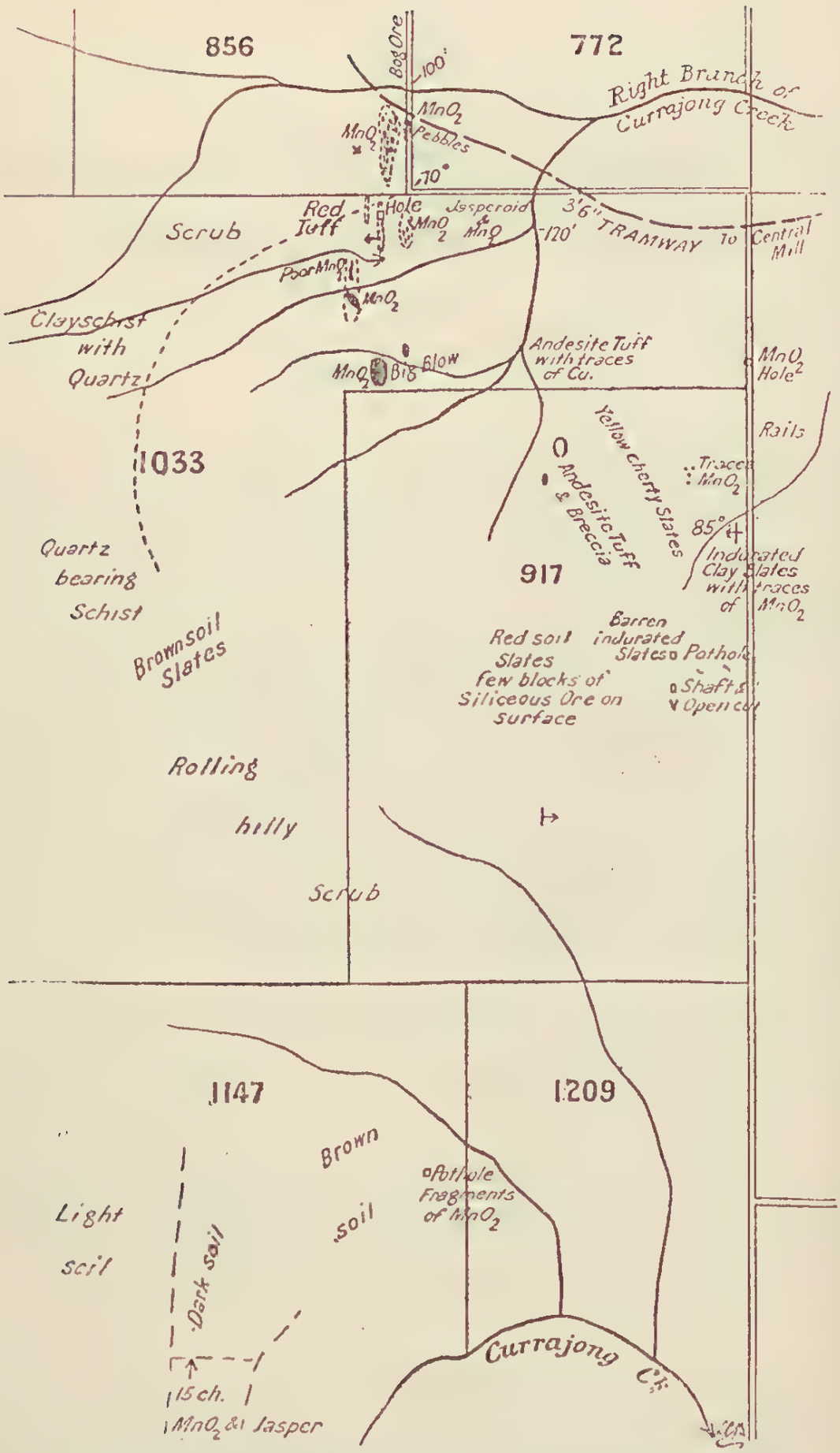
The London quotations for manganese just now (6th November) are:—

Ore containing 50 per cent. and upwards of manganese, 9d. to 9½d.
„ 47 to 50 „ „ „ 8d. „ 9d.
„ 40 to 47 „ „ „ 6d. „ 8d.

i.e., ore containing 44 per cent. of manganese would bring only £1 5s. 8d. per ton. It is evident that only large deposits, most favourably situated, could be made to pay at that price.

GINGIN.

The proved manganiferous country, comprised in an area of 2 square miles, lies 5 miles south-south-west of Gingin Railway Station—the deposits occurring in freehold portions 856, 1033, 917, and 1147, Walla; and Gingin, the centre of a prosperous cane-growing district, is on the Mount Perry Railway, 29 miles from the port of Bundaberg.



Sketch Plan of Manganese Deposits in the Gingin District.

Scale : 20 chains to an inch.

Good, fairly level roads run to Gingin, and the Central Mill Private Railway connects with Wattawa Railway Siding. Arrangements could probably be made with the proprietors of the private railway for the ore to be carried to the siding, and heavy cartage freights might thus be obviated.

The manganiferous country is gently rolling. It was formerly covered with dense scrub, but most of it is now under cultivation, the slates forming a rich brown soil. It is drained by Currajong Creek and its Right Branch, and a feature of the country is the number of springs, some of which persisted even in the drought.

General Geology.

A narrow north-and-south-stretching zone of slates and tuffs of undetermined age includes all the manganese lodes. In one or two places indistinct and indeterminable fossil remains were found in the tuffs near the lodes. The beds strike north and south, and dip at high angles both east and west, owing to folding, consequent on compression from east and west.

Clay schists with segregated lenticules of quartz occur west of the slates, and similar country—probably a continuation of the same belt—exists in the Perry Scrubs to the south (already described in No. 184 of the G.S.Q. publications, and in *Government Mining Journal* for August, 1903, p. 400). The soil produced is comparatively poor, and the quartz blows carry little or no gold.

Immediately east and north-east of the manganiferous area the slates are capped by rich red and black residual basaltic soils, but they have been denuded a short distance to the east and north-east, leaving sandstones and conglomerates (of Trias-Jura age) exposed.

The tuffs and slates are apparently of much younger age than the schists, but are themselves much older than the sandstones and conglomerates. Nothing is known as to the age of the basalt beyond that it is younger than the sandstone; but, as none of these rocks appear to have any connection with the manganese deposits, their age does not really concern the present inquiry.

Portion 856, *Walla.*

The area of manganese ore on this portion is in the extreme south-eastern corner, and extends along the eastern side for 10 chains from the southern end. It consists of scattered pebbles and boulders over a width of from 40 yards at the northern end to 2 yards at the southern. At 6 chains from the southern boundary is a solid outcrop 6 feet wide. The wider parts are due to the occurrence of a number of separate lenses, not to a thickening of one single lens.

The northern portion (with the exception of the western part) is formed of a mixture of hard and soft cellular, slightly ferruginous ore of good quality, but towards the southern boundary the fragments of ore on the surface are often found, when broken, to have a centre of rhodonite (manganese silicate), or else of partly replaced slate.

A general sample, taken from the whole outcrop, assays (Government Analyst):—

Manganese	...	42.4 per cent.
Silica and insoluble ...	...	16.3 ,,

The amount of manganese dioxide was not estimated, but, even assuming the whole of the metal to be peroxidised, it could only amount to 67 per cent., which is rather too low for chemical purposes (Mount Morgan).

The northern end of this deposit is very well worth prospecting, for the discovery of a large lode here would be of great value because of the accessibility of the locality.

Clay slate is the country on the eastern side of the lode, while on the west, together with strongly cleaved clay slates, are highly altered ferruginous andesite tuffs, with casts of indistinguishable fossils and lenticular patches of milk-white calcite.

The road to the east of the northern end of the above deposit, and just south of the Central Mill Tramline Crossing, is covered for a distance of 3 chains with small pebbles of very good ore, possibly derived from a small vein or veins running along the road.

Portion 1033, *Walla.*

Six several areas on this portion have received attention, all lying on the continuation of the zone embracing those in portion 856 and the road adjacent.

Some work has been done 10 chains south-west of the south-eastern corner of 856, a pothole 10 feet deep proving a width of 7 feet of clay-stained manganese ore, seemingly bulging to the south in depth. On the western or hanging wall is a 2-feet band of partly replaced slate, but much of the remainder of the ore is fine-looking blue dioxide, containing, however, much sandy clay, and therefore needing hand-picking and washing. The quality of the ore varies greatly within a space of a few inches, but I believe it will improve with depth. The hanging-wall is fairly well defined and vertical, but the footwall is stained and veined with ore. The country on the west is fissile decomposed purplish tuff slate, dipping 70 to 80 degrees to the west-south-west; while that on the east is decomposed massive slate.

The deposit was found by trenching, and, judging from the fragments on the surface scattered over a width of a chain, it may be 3 or even 4 chains long. A sample from it assays (Government Analyst):—

Manganese	40.5	per cent.
Silica and insoluble ...	20.1	„

This is equivalent to, at the most, 64 per cent. of manganese dioxide.

A second smaller outcrop—probably a separate deposit—is to be seen half a chain up the hill to the west, and partly replaced slate half a chain beyond it.

The next is a couple of chains to the east, on the line of that on the road (referred to under portion 856). Fragments of good ore are scattered over the ground for a distance of 2 chains, and a general sample from them assays (Government Analyst):—

Manganese	47.3	per cent.,

which is equivalent to, at the most, 75 per cent. of dioxide, but all of this is not likely to be available.

The next manganiferous belt is 5 chains west of the pothole, and has a width and a length (south-east) of a chain. Large blocks of rather soft, sometimes quartz-veined, ore, with central pinkish manganese-stained slate (partly replaced) occur half-way between portions 856 and 917, the manganese apparently lying across the belt. The silica will probably decrease with depth. Tuff slate occurs south of the blow.

Some chains south of the last, and within 4 chains of the north-west corner of portion 917, is a large outcrop known as the Big Blow, on the line of the outcrops in portion 856 and that on which the pothole has been opened. Fragments and boulders up to 6 feet in diameter cover an area 2 chains long (north-west and south-east), and a chain across. There are two manganiferous portions separated by about 4 feet of red slaty tuff containing bunches of manganese ore, the south-western about 5 feet wide, the other 3 to 6 feet wide. The dip is about 60 degrees to the south-west, and gradually gets greater with depth. A third outcrop 20 feet to the north-east is 4 feet in greatest width, and consists of somewhat better ore than the others, but, like them, it also passes into jasperoid at the northern end.

A pothole has been opened to 10 feet depth on the two south-western blows, which are shown to be 6 feet thick, and, though very hard on the surface, to soften in depth. The hanging-wall side of the south-western lode contained carbonate of copper stains—the metal having probably been derived from the decomposition of the andesite tuff.

The ore is certainly not good, being slaty and containing white cherty centres. The outcrop may be only a siliceous cap comparable to jasperoid. In fact, the hanging (south-western) wall is red jasperoid, and the country beyond it is yellow indurated clay slate. The country on the footwall is also sometimes jasperised. The country must have been originally very fine bedded (laminated), and is now contorted. A general surface sample assays (Government Analyst):—

Manganese	33.0	per cent.
Silica and insoluble ...	30.2	„
Iron	2.3	„

The available manganese dioxide can therefore not be greater than 52 per cent. in the sample, although specimens have yielded as much as 62.4 per cent. The ore is too siliceous for chemical work, but the silica may decrease below the surface.

An outcrop of similar ore to the above occurs in a gully 3 chains to the east-north-east of the Big Blow, and fragments have been picked up for some distance in the cultivated ground to the north.

Portion 917.

An area of boulders and pebbles of poor ore, 20 feet across and a chain in length (south-south-east), lies 5 chains from the northern boundary about midway between the sides of the portion. The country rock is andesite tuff and breccia. The deposit probably consists of up to 6 feet of partly replaced rock. The ore is very poor; indeed, almost every fragment having a central part of country rock, it is little more than highly stained and partly replaced country rock. Other small outcrops occur a few chains to the south-west and south-east.

The country on the eastern side of the portion is clay slate, dipping at a high angle to the west, and containing traces of manganese at numerous points.

About 25 chains from the northern and 6 chains from the eastern boundary a pothole has been opened on manganese stained and partly replaced clay slates. Tuff slates also occur here. The ore obtained was of no value for any purpose.

Other trenches were opened on stained country a couple of chains to the south, a chain beyond which are a 21-feet shaft and an open cut. The open cut, 30 feet long and 15 feet in greatest depth, was on a bunch of ore dipping south-east. The footwall is mottled, white and yellow sandy slate, the hanging-wall pink pipeclay. The ore passed at a shallow depth into a thin seam of manganese-stained clay. The few tons of ore obtained was of a good quality, a sample of that left on the surface assaying (Government Analyst):—

Manganese ... ... 48.4 per cent.

equivalent, at the most, to 76.5 per cent. of manganese dioxide.

On the one-chain road running north from the north-eastern corner of portion 917 good manganese has been found within 2 chains of that portion. The ore occurred in two over-lapping, north-and-south-striking bunches, 6 and 10 feet respectively in length, making very little outcrop. The ore in the longer northern lens has passed, at 4 feet depth, into manganese-stained material. Some of the ore assayed privately 65 per cent. available manganese dioxide. About 10 tons were obtained, and a sample of that left yields (Government Analyst):—

Manganese	47.2	per cent.
Available manganese dioxide	67.7	„
Silica and insoluble ...	8.2	„
Phosphorus	0.075	„
Sulphur ... trace, less than	0.1	„
Iron	0.91	„

This is rather too low in available dioxide to be accepted at Mount Morgan, but the silica, phosphorus, and sulphur are all within reasonable limits. The country is yellow clay slate striking north and south.

Portion 1147.

A few blocks of manganese dioxide have been found on the north-eastern corner of this portion in brown soil, clay slate country. One specimen from the best block assayed 74 per cent. manganese dioxide, but the greater part of the ore is very poor, and, besides, most of the blocks have slaty silicate centres. Fragments of impure ore can be traced for a quarter of a mile to the south. At one place, 10 chains from Currajong Creek on the east, and 15 chains from it on the south, a pothole has been opened on jasperoid, with a certain amount of ore dipping 45 degrees to the west. Manganese-stained blocks cover an area half a chain in diameter, the amount of manganese may be expected to increase at depth, while the silica will decrease, so that the deposit is worth testing.

Manganese ore has thus been shown to be abundant in this locality, but so far most of it is of rather too poor a quality for it to be payably worked. Manganese ore, however, very often proves far less siliceous at a shallow depth than on the surface, and trial shafts might be sunk with good prospects of finding payable ore.

Bog Ore.—An impure iron-alumina-manganese ore occurs in the flat coal-measure country north of Currajong Creek, often forming a surface deposit 2 feet thick over considerable areas. The deposit is most likely a residual one, formed by the decomposition and leaching of a now denuded cover of basalt. There is no use for such ore just at present, though a demand may arise at any time for any of the metals contained in it.

KALLIWA.

Portion 5*v*, *Kalliwa*, is on the south-western side of Kalliwa Creek, 4 miles above the Burnett River, and 23 miles south-south-west of Gingin. In the cultivation of a small plot of ground on this portion, numerous blocks of manganese dioxide and silicate, together with stained slate, were found. Nothing can now be seen *in situ*, and the ore is not of good enough quality to warrant prospecting work even if there were any prospect of there being a large deposit here. Besides, the distance to a railway (14 miles either to Mount Perry or Degilbo in a straight line), and the roughness of the intervening country, would effectually prevent the present exploitation of any deposit of ordinary size.

DEGILBO.

Portion 54*v*.

Boulders of manganese ore occur over a width of 1 to 4 feet, on an east and west line, for a distance of 15 yards, in about the centre of the western part of 54v, Degilbo. Two tons of ore obtained some months ago averaged 69 per cent. manganese dioxide. A sample of the best ore now on the surface assays (Government Analyst):—

Manganese	52.0 per cent.
Available manganese dioxide	68.0 „
Silica and insoluble ...	6.5 „
Phosphorus	0.08 „
Sulphur ... trace, less than	0.01 „
Iron	1.7 „

This is a very good result, and with hand-picking, it should be possible to bring the percentage of dioxide up to 70 per cent., the minimum accepted at Mount Morgan.

The country rock is slate, but on the northern side of the outcrop jasperoid occurs, with bunches of manganese ore.

The cartage to Degilbo Railway Station (3 miles) costs 3s. 6d. per ton.

Other small bunches of good manganese ore are found in the slates at the northern end of the old Mineral Selection 2307 (on which the Commonwealth Mine is situated), a quarter of a mile west-south-west of the above.

WARWICK.

Mount Gammie lies 5 miles west-south-west of Pratten, and about 1½ miles east of Thane's Creek. The summit is 2,200 feet above sea level, and 800 feet above the general level of the surrounding country. The manganese deposit is on the ridge top, 10 chains south, a little east of the trigonometrical station on the summit, and is reached by a timber track from the Gladstone Mine. It is only a couple of miles from the proposed Thane's Creek station on the Warwick-Goondiwindi Railway, now in course of construction; so that, in the event of the ore being worked, cartage would not be a heavy item of expenditure.

The country rock is sandy clay slate and quartzite, striking a little east of north, while the trend of the ore body, which dips to the east, seems to be generally nearer north and south. It is said that only three blocks of ore outcropped, and no other outcrops are known in the vicinity, though strong stains are very prevalent in the Big Hill adit, 2 miles to the north-north-east.

Over twenty years ago an open cut 6 feet wide, 6 feet deep, and half a chain long, was made in search of ore. At the northern end of the cut there is a great development of quartz, little or no manganese ore, and no jasperoid, but pinkish cherty quartzites. Eight years ago a shaft was sunk at the southern end, to a depth of 15 feet, to test the most promising part of the deposit. Four tons of ore was obtained, with some difficulty, and sent to Sydney, but the contents were not reported.

In the shaft is 6 feet of manganiferous rock, but veins and stains of the mineral extend out into the adjacent country, sometimes for several feet. A large amount of quartz occurs as bunches in the same formation. About a quarter of the formation is manganiferous, but only about a quarter of that is good ore. It is thus evident that special cleaning machinery would be necessary in order to work the ore. The ore occurs as bunches up to 50 lb. in weight, surrounded by decomposed country. A few tons of comparatively poor ore now lie on the surface, the best material in which assays (Government Analyst):—

Manganese ... ... 48.9 per cent.

There certainly seems to be a slight improvement in depth, so that the deposit is well worth prospecting.

LIONEL C. BALL,
Assistant Government Geologist.

Brisbane, 23rd December, 1903.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

VICTORIA.

Queensland.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY OF QUEENSLAND.
Publication No. 193.

REPORT.

WET PROCESSES OF COPPER EXTRACTION,

With Special Reference to Queensland Ores.

By LIONEL C. BALL, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

BRISBANE
BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1904

LETTER OF TRANSMITTAL.

Geological Survey Office,
Brisbane, 27th April, 1904.

Sir,—I have the honour to forward for publication a Report by Mr. Ball entitled "Notes on Wet Processes of Copper Extraction, with Special Reference to Queensland Ores."

The paper contains much useful information compiled from various publications, and, although it does not pretend to be exhaustive by any means, it will be a general guide to the wet processes of copper extraction so far as they may be applied to Queensland.

I very much desired a bibliography of the subject to be incorporated with the paper, not only of those works consulted, but those which were not available to us and those which time did not permit being consulted; but, as this would cause some delay in its issue, it was deemed advisable to leave the bibliography for some future publication.

A critical discussion of its contents may be anticipated after publication; but due allowance must be made of the fact that the compilation has of necessity been hurriedly performed, and that such work is not quite on the lines laid down for the work of a geological surveyor.

I have, &c.,

B. DUNSTAN,
Acting Government Geologist.

The Under Secretary for Mines.

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WET PROCESSES OF COPPER EXTRACTION.

WITH SPECIAL REFERENCE TO QUEENSLAND ORES.

I.—Introduction.

Renewed interest has of late been taken in the copper ores of the Cloncurry district, and inquiries have been made as to the best method of treating them. Wet processes have been brought under notice by miners having during the past couple of years treated the cupriferous waters of the Dee River below the Mount Morgan works (where copper is now saved by the company) and by trials made with ores from the Chillagoe district. Consequently, brief descriptions of the different wet processes which are practised in other parts of the world, and which are most likely to be suitable for Queensland ores, have been prepared.

In the following pages, after mentioning some of the Queensland deposits available for wet processes, will be given in detail—the various copper ores likely to be treated, the preparation necessary for the various ores, and the processes for dissolving the copper salts, followed by the methods of precipitating the copper or its salts, together with brief notes on its subsequent treatment. In no case is a single process fully described under one heading, and therefore in a summary all the processes are either briefly described or graphically represented. The electrolytic methods of extracting copper are not referred to in detail, as the cost of installation and the absence of water power seem to prohibit their use in Queensland.

A few details on plant, construction, treatment, and costs are given under the concluding remarks, but these are matters that will have to be determined in each particular case by the metallurgist in charge. Very little has been written concerning the cost of construction, and the items will therefore require to be determined when the amount of ore to be treated and the process to be employed are decided on.

In compiling the following notes references have been made to the following publications:—Schnabel and Louis' "Handbook of Metallurgy," the volumes of the "Mineral Industry," Eissler's "Hydro-metallurgy of Copper," Phillips and Bauerman's "Elements of Metallurgy," "The Journal of the Society of Chemical Industry," and "The Engineering and Mining Journal."

1.—HISTORY.

The hydro-metallurgical treatment of copper ores, first employed in connection with the recovery of copper by precipitation from mine waters, has been practised for centuries, but only came into prominence in the latter part of the nineteenth century. There are now numerous processes differing in detail, but alike in broad principle—viz., rendering the copper in the ore suitable for solution (by oxidising or chloridising), dissolving the copper salts in suitable solvents (sulphuric acid, hydrochloric acid, ferrous chloride, &c.), precipitating the copper (by metallic iron, sulphuretted hydrogen, milk of lime, &c.), reducing the precipitate to metallic copper, and refining the same (in the dry way).

At Rio Tinto, Spain, where leaching processes have been most fully developed, natural oxidation was first employed: then heap roasting; and now lixiviation with brines is practised for the poorer ores, while the richer ores are smelted.

2.—APPLICABILITY.

(*a*) General.

Wet processes are employed for—

(i.) Very poor ores and the by-products (containing in exceptional cases as little as ½ to 1 per cent. copper), treated or obtained in connection with the manufacture of sulphuric acid and iron;

(ii.) Poorer siliceous copper ores, free from lime, magnesia, ferrous oxide, and manganese.

They are specially applicable for pyritic ores so low in copper that they could not be profitably smelted either directly or after roasting, but they are not suited to pyritous ores high in copper, which therefore go to the smelter. Wet processes have been used for the tailings obtained in the mechanical concentration of ores, but it is considered better, if leaching is to be used at all, to leach the whole of the ore without any concentration. Mr. Peters, one of the greatest authorities on copper smelting, places the matters thus[1]:—

> The slow Rio Tinto method of leaching is the most favourable of the processes for treating low grade siliceous ores where the magnitude of the ore bodies and the financial resources permit of its application. An intimate knowledge of local conditions and costs, wide technical experience with modern lixiviation plants and long and careful experiments on an extensive scale on the ore to be treated can alone decide the method to be chosen in any case. The only definite rule given is to crush the ore dry and roast it before lixiviation.

Mr. Peters, however, in the above article, apparently overlooks the new processes of Neill and Van Arsdale, which have every likelihood of coming into extensive use.

The product of most of the wet processes is simply an impure metal, and in their case the treatment would really be equivalent to a concentration. In certain other cases (notably Neill's) the product is an almost pure copper.

(*b*) Available Deposits in Queensland.

The wet methods of extraction appear to be specially applicable to the ores of many localities in this State, of which the following are instances:—

Cloncurry.[2]—The great obstacle to smelting at Cloncurry is the absence of a coke fuel, and the want of a railway to the coast has prevented the exportation of any but the very richest ores.

The deposits lie in various directions, from 1 to 80 miles distant from the township, necessitating separate treatment works for each group. They vary in width from 10 feet to 50 feet. At Hampden Mine is a belt of cupriferous slates 200 feet wide and 40 chains long. The lengths of the bodies have not yet been determined, and Mr. Cameron considers much additional prospecting necessary. The surface ores are mixtures of carbonates and oxides in a siliceous

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[1] "Treatment of Low Grade Siliceous Ores." By Ed. D. Peters, in Min. Ind., Vol. XI.; also in "Engineering and Mining Journal."

[2] Reports on the Geological Features of Part of the District to be traversed by the proposed Transcontinental Railway. By Robert L. Jack, Bris. By Auth.: 1885. G.S.Q. Publication No. 136.

[3] Recent Developments in the Copper Mining Industry in the Cloncurry District. By Walter E. Cameron, B.A., Bris. By Auth.: 1900. G.S.Q. Publication No. 153.

gangue, and therefore specially suitable for wet treatment, and by the time they have been exhausted sufficient modifications will have been introduced into the plant for the sulphides to be treated.

Timber is not very abundant over the district as a whole, but there seems to be sufficient for roasting purposes.

Chillagoe.[3]—The surface ores of this large district are oxides and carbonates in a ferruginous matrix, and they and the poorer sulphides would probably give good results with wet processes. In fact, tests have already been made by the directors of Tartana, Limited, proving that the copper in their ore may be leached without crushing smaller than three inches diameter.

Watsonville.[4]—In the North Australian Mine copper is developed somewhat extensively in slates.

Kangaroo Hills.[5]—The feature of the copper ore is the high silver contents —10 oz. silver per unit copper. Deposits up to 12 feet of carbonates and oxides in a siliceous matrix (Mount Thekla) are found, passing in depth into copper, lead, and zinc sulphides.

Moonmera.[6]—A deposit of breccia, with distributed carbonates, sulphide, and native copper, several feet wide. The mine is convenient to railway.

Mount Morgan.—At Mount Morgan the iron pyrite of the upper levels is becoming cupriferous in the lower workings, and, after treatment by chlorination for gold, the copper is now being precipitated. There is really a possibility of the great gold mine yet producing large quantities of low-grade copper ore, the metal in which may be saved by wet processes by modifications in the present plant and working.

The copper deposits at *Mount Perry*[7] and *Peak Downs*, owing to their comparative smallness and richness, are not specially available for wet treatment, but are more suitable for smelting.

Many Peaks.—The Many Peaks ores are in many points similar to those of Rio Tinto. The sulphides are massive and low in grade. The copper is readily leached out without the necessity of roasting, and without decomposition of the pyrite. The Many Peaks deposits seem to be somewhat bunchy, varying from a few feet up to ten feet in thickness: while the copper contents are about 4½ per cent.[8]

Glassford Creek[9].—The Glassford Creek deposits are low in grade, but magnetic separation followed by smelting should give the best results. It would not be possible to roast the ores as mined without a ruinous expenditure of fuel, and the ores are not suitable for leaching.

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[3] Op. cit. G.S.Q. Publication No. 167.

[4] Tin Mines of Watsonville, &c. By Sydney B. J. Skertchly, Bris. By Auth.: 1897. G.S.Q. Publication No. 119.

[5] Kangaroo Hills Mineral Field. By Walter E. Cameron, B.A., Bris. By Auth.: 1901. G.S.Q. Publication No. 167.

[6] Annual Report for year 1898 of B. Dunstan. G.S.Q. Publication No. 143.

[7] Since the above was written, it has been found that a wet process is now in operation at Mount Perry for the treatment of a certain class of ore—the poorer siliceous portion, which is obtained owing to the impossibility, because of the narrowness of the veins, of mining the ore free from country rock.

[8] Annual Progress Report. W. H. Rands, 1899. G.S.Q. Publication No. 150.

[9] Report on Certain Iron Ore, Manganese Ore, and Limestone Deposits in the Central and Southern Districts of Queensland. By L.C.B., Bris. By Auth.: 1901. G.S.Q. Publication No. 194.

Silver Queen, Severn River.[1]—Bunches up to twenty feet in width of low-grade and very siliceous copper lead zinc ore. An attempt is now being made to mechanically concentrate the ore, which contains: copper, 1.26 per cent.; lead, 7 per cent.; zinc, 8.8 per cent.; silver, 17 oz. 12 dwt. per ton; and gold, 16 gr. per ton. The Hunt and Douglas Process (*see* under "Solution") seems to be the most promising process for this ore.

3.—COPPER ORES.

The ores suitable for treatment by hydro-metallurgical methods may be arranged under four heads:—

(A.) *Oxides.*—These occur in the weathered part of copper deposits, more especially in the zone of enrichment near the water level. Two forms occur in nature—(*a*) *Cuprite* or Red Oxide (Cu_2O), when pure containing 88.8 per cent. of copper; and (*b*) *Tenorite*, Melaconite, or Black Oxide (CuO), containing 79.85 per cent. copper.

(B.) *Carbonates.*—Carbonates are the chief copper minerals in the portions of ore deposits above water level. The two forms are:—(*a*) *Malachite*, or green carbonate ($CuCO_3.CuH_2O_2$), containing 57 per cent. copper; and (*b*) *Azurite*, or blue carbonate ($2CuCO_3.CuH_2O_2$), containing 55 per cent. copper.

(C.) *Chloride* (or Oxychloride).—This mineral occurs sometimes in considerable quantity in the weathered part of ore bodies. (*a*) *Atacamite* ($CuCl_2.CuO.3H_2O$) contains 59.4 per cent. copper.

(D.) *Sulphate.*—Sulphate is a common decomposition product in copper mines below the water level, and, owing to its easy solubility, is usually found in the drainage water from mines. The natural mineral is *Chalcanthite* ($CuSO_4.5H_2O$), containing 25.4 per cent. copper.

(E.) *Sulphides.*—Practically all copper exists below water level in the form of sulphides. The sulphides are by far the most important, though as a rule much poorer in copper than the oxidised ores. The minerals are: (*a*) *Chalcocite* or Copper Glance (Cu_2S), containing 80 per cent. copper; (*b*) *Covellite* (CuS), containing 66 per cent. copper; (*c*) *Bornite* or Erubescite ($3Cu_2S.Fe_2S_3$), containing 55.6 per cent. copper; and (*d*) *Chalcopyrite*, or Copper Pyrite ($CuFeS_2$), containing 34.4 per cent. copper. The last is the most common and abundant, the others being chiefly secondary products, causing enrichment, but not as a rule of any extent. It usually occurs with pyrite (FeS_2), so that the ore as mined may contain far below 34 per cent. copper, and may sometimes be really only coppery iron pyrite.

II.—Preparation of the Ore for Solution.

A.—OXIDES.

Except in the Hunt and Douglas Process, in which it is necessary to oxidise the cuprous oxide to cupric oxide by moistening and exposing to the atmosphere, preliminary preparation is not absolutely required if the ore contain no sulphides; but, as already mentioned, it is held to be advisable to roast the ore in all cases, to render it pervious to solutions, even if it does not actually need the roast for chemical reasons.

[1] Notes on Tin, Copper, and Silver Mining in the Stanthorpe District. By L.C.B., Bris. By Auth.: 1904. G.S.Q. Publication No. 191

B.—CARBONATES.

Usually no preliminary treatment is given beyond roasting (necessary in the Hunt and Douglas Process, where, if CO_2 is not previously driven off, it causes loss by effervescence during treatment). But the following modification of sulphuric acid leaching comes under "Preparation."

Ex.: At Stadtberge, in Westphalia, an ore consisting of azurite and malachite in quartzose schist (containing a half to two per cent. copper) after crushing was treated for eight or ten days with a mixture of sulphur dioxide, nitrous oxides, and water vapours, in a brickwork tank with a false bottom of fire brick, and having a capacity of 65 tons ore.

C—CHLORIDE.

The chloride needs no preparation.

D.—SULPHATE.

Being soluble in water, the sulphate is treated direct.

E—SULPHIDES.

Being imperfectly and very slowly soluble in acids or ferric sulphate, sulphides are converted into: Oxide, sulphate, sulphite, or chloride.

1. Conversion into Oxide.

Acid (ferrous chloride, &c.) being required for its solution, the oxide is only very exceptionally produced intentionally.

(i.) *By Roasting.*

In the New Hunt and Douglas Process a preliminary roast is necessary for sulphides, and the temperature of the roast must be carefully regulated, for if too high the oxides produced would not be attacked, and if too low sulphate is formed, and increases the consumption of iron during precipitation.

Ex.: At Ore Knob, North Carolina, U.S.A., the ore is roasted in three hearthed reverberatories producing a cinder containing 7.75 per cent. CuO and 4.15 per cent. $CuSO_4$.

2. Conversion into Sulphate.

One of the four following methods may be employed:—

(i.) *Atmospheric Oxidation.*

Natural weathering can be employed only for easily decomposed ores, owing to the length of time required to render the whole, or even the greater part, of the copper soluble. It has been stated that for this method to succeed the copper must be present in the ore as chalcocite (in which form it occurs in the Rio Tinto pyrite), oxidation in the case of covellite being slow, and in the case of chalcopyrite practically absent.[1] The method is the cheapest of all as far as the treatment itself goes, but the length of time required, the large capital locked up, the imperfect extraction, and the uncertain action of new ores, even when they can be found in sufficient quantity, have prevented the extension of its use. It has been proposed to employ the method at Many Peaks, in the Gladstone district. The ore here is a dense low-grade sulphide from which the copper is readily leached without decomposition of the iron sulphide.

Ex: At Rio Tinto, in the Province of Huelva, Spain, atmospheric oxidation without roasting is employed. The ore, containing 2.8 per cent. copper, is broken to three-inch

[1] "Wet Methods of Extracting Copper as adopted at Rio Tinto, Spain." By Charles H. Jones, Am. Inst. Min. Eng. February, 1904. *Vide* Eng. and Min. Journal.

size and piled on clay floors in heaps 15 to 30 feet deep, containing several millions tons of ore, "fines" and "coarse" being in alternate layers. The heaps are ventilated by rough stone flues and chimneys, and the surface is cut up by a system of gutters in which the leaching waters, which first start the oxidation and later dissolve the salts, are run. The temperature is regulated to about 100 degrees Fah., below which oxidation is slow, and above which, owing to the generation of steam, free ingress of air is prevented.

Ex.: At San Domingos, in Portugal, two and a-half to three per cent. ores were formerly broken to lumps the size of the fist and piled in heaps 15 to 40 feet thick. They were treated as above.

(ii.) *Slow Heap Roasting.*

Artificial cementation is most suitable for pyritous ores poor in copper, but the fumes produced are a great nuisance. Owing to the impossibility of oxidising all the sulphide and to the formation of some copper oxide during the roast, it is necessary, after a preliminary leaching, to expose the ore to the weather for many years, to complete the formation of sulphate.

Ex.: At Rio Tinto, the process has been used for one and a-half to two per cent. ores, which were roasted over brushwood, firewood, or coals, in heaps of from 200 to 1,500 tons, the amount of firewood required being one quarter cubic foot per ton of ore. The smaller heaps burn for two months and the larger for six months, but the former give the better result. After leaching (as described below under "Solution of the Copper Salts"), the residues, containing about one half per cent. copper, are built, while moist, into heaps ("torreras") which contain several million tons. The sulphides in the heaps decompose with increase of temperature, and given sufficient time the oxidation of the copper will be complete. Leaching of the "torreras" is begun after four to six months.

(iii.) *Heap Roasting with Ferrous Sulphate.*

This is suited for pyritic ores poor in copper, and especially for fines. The ferrous sulphate is obtained as a by-product when the copper is precipitated from the sulphate solution by means of iron. The action of the sulphate is shown in the equation below:—

$$CuFeS_2 + FeSO_4 = CuSO_4 + 2FeS.$$

Ex: At Agordo, in the Venetian Alps, Italy, one to two per cent. fines are crushed, and made into a paste with the mother liquors, containing ferrous sulphate, from the precipitation of copper; the paste is cast in moulds, air-dried for three weeks and built into heaps, which are covered with "smalls" and calcined for from four to five months.

Ex.: At Majdanpec, in Servia, two per cent. mixed sulphide, carbonate, and oxides ores, containing one per cent. sulphuric acid and eight per cent. magnesium and aluminium sulphates (which act in the same way as ferrous sulphate), after drying for a month, are made into heaps of 300 tons each and calcined for three months, with a consumption of seven tons of firewood per heap.

(iv.) *Leaching.*

(*See* under "Solution of the Copper Salts.")

3. Conversion into Sulphite.

(i.) *Roasting and Sulphurous Acid.*

Sulphite is prepared with sulphur dioxide, which affects only the oxide or carbonate, and sulphides have therefore to first receive a thorough oxidising roast.

Neill's Process[1] is primarily for oxides and carbonates in a siliceous gangue, preferably one free from lime and magnesia, but with a preparatory roasting it is just as applicable to sulphides. The process when described had not yet passed out of the experimental stage. It is intended for remote localities where fuel and fluxes are not obtainable.

4. Conversion into Chlorides.

Cupric and cuprous chlorides are produced either by a wet or a dry method.

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[1] "Leaching of Copper Ores by Sulphurous Acid." By E. P ennings. Eng. and Min. Jour., March, 1901.

(*a*) *Wet Methods.*

For ores requiring no preliminary preparation, the methods will be found under "Solution of the Copper Salts," but for ores containing sulphides the following method may be used:—

(i.) Chlorination by leaching with ferrous chloride and hydrochloric acid (acidified mother liquors).

Ex.: At Stadtberge the heaps of sulphides, &c., with two to two and a-half per cent. copper, are leached with mother liquors (containing ferrous chloride) acidified with hydrochloric acid. Part of the copper is dissolved, and the remainder is either chloridised or sulphatised by exposing to the atmosphere for a period of three months. The silver in the ore is converted into chloride by the addition of common salt.

(*b*) *Dry Methods.*

(i.) Henderson's or, more properly, Longmaid's Process. The commercial introduction of this process, which is comparatively rapid and thorough, was the cause of the reopening of several important mines in Spain and Portugal; and, besides, it is used in several countries in Europe for ores containing from three to eight per cent. of copper—especially for the residues from the manufacture of sulphuric acid.

Henderson's patent was to volatilise the chlorides and dissolve the copper remaining with acid; but, the amount of chloride volatilised being insignificant, the following modification was made. The ores are first subjected to an oxidising roast at a moderate temperature, in heaps or in shaft furnaces, followed by a chloridising roast, with 15 per cent. common salt, in reverberatory or muffle furnaces, to convert the copper into chloride (cupric chiefly, but with a little cuprous). The process depends on the sulphur in the calcined pyrite, causing the formation of copper sulphate, which, by double decomposition with the common salt, forms cupric and cuprous chlorides, as shown in the following equations:—

$$2FeS_2 + 4CuO + 15O = 4CuSO_4 + Fe_2O_3.$$
$$4CuSO_4 + 8NaCl = 4CuCl_2 + 4Na_2SO_4.$$

There is also unavoidably a little copper oxide and sulphide present.

The aim is to produce the maximum quantity of cupric chloride (which is soluble in water), and a minimum quantity of ferric sulphate (which increases the consumption of iron in precipitation). These desiderata are obtained by the use of ores containing less than eight per cent. copper (a greater quantity is difficult to oxidise and chloridise), by regulating the amount of sulphur to $1\frac{1}{2}$ times that of the copper in the ore (any excess forming ferric sulphate), and the maintenance of a uniformly low red heat (a greater heat causing volatilisation of cupric chloride). The gases (sulphur dioxide, hydrochloric acid, and chlorine) produced by the roast are absorbed by falling water in masonry towers.

Ex.: The process, with modifications, was formerly used at Rio Tinto, where $2\frac{3}{4}$ per cent. ores were roasted in heaps with 40 lb. common salt to the ton, and leached with water to extract the copper (about one-fifth) rendered soluble.

$$FeS_2 + H_2O + 7O = FeSO_4 + H_2SO_4;\ CuO + H_2SO_4 = CuSO_4 + H_2O.$$

The residue was then removed and further roasted for four to six months while subjected to the oxidising action of sulphuric acid formed by the oxidation of sulphur dioxide from a covering of raw ore.

$$SO_2 + H_2O + O = H_2SO_4.$$

The ore was mixed with two or three per cent. of common salt and manganese dioxide for the purpose of producing copper chlorides:

$$4NaCl + 2H_2SO_4 + MnO_2 = MnCl_2 + 2H_2O + Cl_2 + 2Na_2SO_4.$$
$$CuSO_4 + Cl_2 = CuCl_2 + SO_2 + O_2.$$
$$Fe_2O_3 + 3Cl_2 = Fe_2Cl_6 + O_3.$$
$$3CuSO_4 + Fe_2Cl_6 = 3CuCl_2 + Fe_2(SO_4)_3.$$

Ex: The richer coarse ore at Rio Tinto was (in 1892) roasted in piles with two per cent. common salt, rendering a quarter of the copper present soluble. The residue after leaching was subjected to a further roasting.

Ex.: At Oker, in Germany, an ore having the following composition was treated:—pyrite=60 per cent.; chalcocite=23 per cent.; blende=6 per cent.; galena=2 per cent.; gangue = 9 per cent. After calcination in pyrite burners connected with sulphuric acid works, the ore was mixed with 15 per cent. of mixed alkaline chlorides and ground to 0.08-inch mesh. The mixture was charged 2½ tons at a time into a gas furnace, and heated to low redness for four hours; rabbled for five hours without firing and with open ports; and then drawn. In this manner five tons were worked off per twenty-four hours with a consumption of 10 per cent. coal; 75 per cent. of the copper contents were rendered soluble in water (cupric chloride and neutral sulphate), 20 per cent. soluble in dilute acids (cuprous chloride, cupric oxychloride, oxide and basic sulphate), while 5 per cent. was soluble only in aqua regia (cuprous sulphide).

Ex.: At Antwerp, four per cent. ores from Norway, containing five per cent. sulphur after treatment in sulphuric acid works, are crushed and mixed with 20 to 25 per cent. common salt. They are then roasted for six hours with a temperature of 500 degrees to 600 degrees C. in a muffle furnace, holding 3¾ and 4½ ton charges, and reducing the sulphur to 0.20 per cent. The copper is then in the form of cuprous chloride and oxide.

$$2CuS+2CuO+4NaCl+7O = 2CuCl+Cu_2O+2Na_2SO_4+Cl_2.$$

Ex.: At Natrona,[1] Pennsylvania, Spanish pyrites cinders, containing two per cent. copper are treated. The cinders are ground with 10 per cent. common salt, and roasted in 4½-ton lots in muffle furnaces at a dull red heat (800 degrees Fahr.) for eight hours. The copper is then chiefly chloridised.

Ex.: In Great Britain, Henderson's Process is combined with the Claudet Process (for precipitating silver as iodide). The ore, after roasting in muffle furnaces at a dull red heat with from 13 to 20 per cent. common salt, contains 77 per cent. chlorides and 20 per cent. oxide. The gases given off are condensed and used for leaching.

Ex.: At Falun, Sweden, 3½ per cent. hard ores are roasted in heaps driving off 10 per cent. sulphur; mixed with 14 per cent. common salt and ground in ball mills; subjected to a chloridising roast in Howell and White calciners with continuous charging, 15 tons in twenty-four hours. When completely chlorinated, the ore is transferred to wooden vats, and cupric chloride is dissolved by a first wash of weak acid, a second of weak liquors from a previous charge, and a third of clean water.

(ii.) Hoepfner in 1902 took out a patent in the United States by which—

1. Sulphides are roasted and sulphur dioxide is condensed.
2. Copper sulphate is converted into cupric chloride by common salt.

III.—Solution of the Copper Salts.

The methods of dissolving the salts will be given in the order in which the salts have been prepared.

A. AND B.—OXIDE, CARBONATE, AND ARSENATE.

These, either native or artificial, may be dissolved by the following solvents, of which, owing to their energetic action, the acids are to be preferred, whenever their cost will allow, except in cases where the ore contains substances (such as carbonates) soluble in acids:—

(*a*) By Sulphuric Acid (H_2SO_4).

The acid is prepared in sulphuric acid chambers from pyrite and nitre, and leaching of the ore takes place in lead-lined or stone chambers.

The only objection to the employment of sulphuric acid is that basic salts are formed, as well as ferric sulphate and free sulphuric acid, which cause loss of iron during precipitation of the copper.

Ex.: Stadtberge.

[1] "Extraction of Copper from Burnt Pyrite." By Joel P. Clemmer, in Min. Ind., Vol. VIII.

The latter difficulty—the loss of iron—is overcome in Van Arsdale's Process,[1] in which sulphur dioxide, derived from the roasting of sulphides, is used as a precipitant. This process, patented in 1903, purposes to extract the copper from low-grade ores by means of already heated sulphuric acid solution, containing incidentally copper sulphate. The solvent is regenerated in the precipitation of part of the copper, and used for fresh ore after expulsion by heat of any sulphur dioxide contained. As a matter of fact, the SO_2 is expelled simply by releasing the pressure in the pressure tank, which is already heated. Iron and other substances are dissolved as well as copper, and the solution has, therefore, from time to time to be neutralised, when, on heating and injecting air, the iron is precipitated, and carries down arsenic and other impurities. Iron, if not present in greater quantity than the copper, does not interfere with the reactions.

(*b*) By Hydrochloric Acid (HCl).

This acid is preferred to sulphuric acid because of the smaller proportion of basic salts formed, although its consumption is greater owing to the iron oxides in the ore being attacked during the leaching operation.

Ex.: At Stadtberge, Westphalia, hydrochloric acid, owing to its cheapness, was used after the abandonment of the sulphuric acid process. The leaching tanks were of wood, and held from 29 to 90 tons of ore. The solutions, gradually increasing in acidity, were allowed to remain twelve hours in each tank, and saturation was obtained in from ten to twelve days. The acid required amounted to from five to seven times the weight of the copper.

Ex.: In Waldeck, Germany, attempts were made to extract the copper (three-quarters to one per cent.) in the Bunter Sandstone, but failed because of the presence of half to one per cent. lime, which had to be first dissolved. The ore was crushed and charged into sixteen tubs 13 feet in diameter and 4 feet deep, furnished with agitators; 20 tons of ore were treated per day, the ore being delivered at the works at 4s. per ton. The impure acid used cost 2s. per 100 lb., and each ton of ore required 400 lb. of acid, which before use was diluted with water.

A slight modification of the acid process has been patented (December, 1901) by Waterbury in the United States. Ore is to be leached with acid in a tank, hot air being forced in at same time from a perforated pipe near the bottom of the tank.

(*c*) By Ferrous Chloride ($FeCl_2$).

This salt may be used for dissolving cupric oxide and carbonate or roasted sulphides, forming cupric chloride (soluble in water) and cuprous chloride (soluble in excess of ferrous chloride).

$$3CuO + 2FeCl_2 = CuCl_2 + 2CuCl + Fe_2O_3.$$
$$3Cu_2O + 2FeCl_2 = 4CuCl + Fe_2O_3 + 2Cu.$$
$$2CuO + Cu_2O + 2FeCl_2 = 4CuCl + Fe_2O_3.$$

The cupric chloride itself decomposes copper sulphide as well as silver sulphide.

$$Cu_2S + 2CuCl_2 = 4CuCl + S.$$

(i.) *Direct Action of Ferrous Chloride on the Oxidised Ore or Roasted Sulphide.*

(Old Hunt and Douglas Process.)

The ore is agitated in wooden vessels with ferrous chloride solution (prepared by mixing ferrous sulphate and common salt, and crystallising out the sodium sulphate). The ore and solution are kept at a temperature of about 70° C. till—after three or four days—the copper has dissolved, when the

[1] Engineering and Mining Journal, 6th June, 1903.

solution is filtered from the precipitated ferric oxide. The process was formerly much used in the United States, its advantages being the small consumption of iron, the absence of a chloridising roast, and the small amount of fuel needed: but the trouble in separating the ferric oxide has caused its almost complete abandonment. Another disadvantage is that, owing to the presence of cuprous chloride, which forms an insoluble iodide, the Claudet Process for separating the silver is not available.

Ex.: At Ore Knob, North Carolina, U.S.A., calcined ores containing 7·75 per cent. oxide and 4 per cent. sulphate were leached with ferrous chloride solution in wooden vats six feet in diameter, holding 1½ tons of ore. After stirring for eight hours, the ore was allowed to settle, and the solutions drawn off for precipitation.

(ii.) *Indirect Action of Ferrous Chloride on Roasted Ore, followed by a Sulphuric Acid Leaching.*

(New Hunt and Douglas Process.)

This modification was devised because of the trouble in separating the ferric oxide and the difficulty in saving the silver by the old process. Its great advantage is the rapidity with which solution takes place.

Ex.: At Kansas City, Missouri, U.S.A., this process is used for calcined argentiferous lead-copper mattes containing up to 300 oz. silver per ton and 30 per cent. copper. After an oxidising roast at a low temperature, the copper oxide and sulphate formed are dissolved with dilute sulphuric acid. The addition of common salt to the solution results in the formation of ferrous chlorides, which converts the copper sulphate into cupric chloride (in greater part). The common salt must not be in excess, as silver chloride would be dissolved. Calcium chloride (obtained by the precipitation of copper with milk of lime) may be used to chloridise the copper, but in this case a precipitate of calcium sulphate has to be filtered off. The silver, precipitated by cuprous chloride, and lead remain undissolved, and may be obtained separately.

(*d*) By Sulphurous Acid (SO_2).

(Neill's Process.)

The sulphur dioxide, produced either from the roasting of pyrite or of the copper ore itself if it be a sulphide, attacks copper oxide or carbonate, forming sulphite ($Cu_2SO_3.H_2O$), which remains in solution in excess of sulphurous acid.

$$2CuO + H_2SO_3 = Cu_2SO_3 + H_2O + O.$$

Lime and magnesia, being soluble in sulphurous acid, are objectionable because they increase the consumption of sulphur dioxide, but otherwise they are inert. Very little of the other metals in the ore are dissolved, and the copper is therefore obtained in an unusually pure condition.

In practice it is proposed, after crushing the oxides, carbonates, or roasted ore to a 20-mesh screen, to charge into covered wooden tanks, containing water (two tons per ton of ore) with a little absorbed sulphur dioxide, the washings from the previous charge and from the gas absorption tower connected with the leaching tank. The sulphur dioxide is forced under pressure by air compressors into the false bottom of the leaching tank in which ore and liquid are kept in continual agitation by the gases. The solution could be completed in from one to four hours in a single tank, but it is better to have a series, one over the other, so that the gas from the lowest can be passed into the others. From the leaching vats the pulp and solution are delivered into a storage vat from which the solution and slimes are forced by compressed air into a filter press, to separate the solution from the pulp. The sands in the tank and slimes in the filter press are washed with a small quantity of water acidified with sulphuric acid which is either passed on to the steaming tank or back to the leaching tank.

This process seems to be most admirably suited to our inland copper districts, owing to the low cost and small amount of solvent used, to the simplicity of the plant (even simpler than that successfully used in the sulphuric acid process), and to the ease of reduction of the copper salt obtained. It is true that its adoption would be in the nature of an experiment, and many

difficulties would necessarily have to be overcome, but the small amount of fuel needed, the cheapness of the treatment, the availability of the solvent, and the pure product obtained all give it a strong claim for a trial.

Ex.: Experiments on silicified Triassic sandstone containing blue and green carbonates with some oxide have proved that 95 per cent. of the copper can be dissolved in four hours.

(*e*) By Ferric Chloride (Fe_2Cl_6).

The ferrous chloride in the liquor obtained in the precipitation of hydrochloric acid solutions is oxidised on exposure to the atmosphere to ferric chloride, which is capable of dissolving metallic copper, cuprous and cupric oxides, and copper carbonates.

(*f*) By Other Solvents.

Ammoniacal compounds and sodium hyposulphite have been suggested, but they are either too slow in action or else too expensive for practical use.

C.—CHLORIDES.

Cupric chloride is soluble in water, but cuprous chloride requires the addition of ferric chloride or ferrous chloride and hydrochloric acid.

(*a*) By Water.

Leaching with water is used in the Henderson Process to extract the cupric chloride.

Ex.: At Rio Tinto, about one-fifth of the copper contents was extracted after the chloridising roast.

Ex.: At Oker, three-quarters of the copper contents was rendered soluble in water.

Ex.: At Natrona, the chloride produced was leached out with water and the ferric oxide residue sent to iron works.

Ex.: In England, tanks of wood tightly caulked, and 10 ft. × 11 ft. × 4 ft. deep, are used with removable false bottom of perforated tiles or firebrick covered with a three-inch layer of cinders; fifteen-ton charges; nine to ten successive washings of water, condensation tower liquors, or very weak cupriferous solutions from the previous leachings, the last two washings being acidified. The leachings require forty-eight hours and the copper contents are reduced to 0.18 per cent.

(*b*) By Ferric Chloride.

In the Henderson and Dotsch Processes ferric chloride leaching is employed in extracting the cuprous chloride. Direct leaching is not advised unless the cost of fuel prohibits a chloridising roast.

(i.) Direct leaching with ferric chloride.

Ex.: At Rio Tinto, the method employed to replace the Dotsch Process for fines is to simply leach them in tanks with ferric chloride solutions obtained during the precipitation of copper dissolved from the roast heaps. The following are the reactions involved:—

$$CuS+Fe_2Cl_6 = CuCl_2+2FeCl_2+S\text{; and } Cu_2S+Fe_2Cl_6 = 2CuCl+2FeCl_2+S.$$

(ii.) Indirect leaching with ferric sulphate and common salt (Dotsch Process).

Ex.: At Rio Tinto, a process was formerly in use for cupriferous pyrite fines, containing $2\frac{3}{4}$ per cent. copper. The ore was crushed fine by rock breakers, mixed with $\frac{1}{2}$ per cent. common salt and stacked in heaps, 50 feet square and 13 feet high, traversed by dry stone flues. The heaps were then drenched with a mixed solution of ferric sulphate and common salt.

$$Fe_2(SO_4)_3+6NaCl+3O = Fe_2O_3+3Na_2SO_4+6Cl.$$
$$2FeSO_4+4\,NaCl+3O = Fe_2O_3+2Na_2SO_4+4Cl.$$

The chlorine freed attacks both copper and iron sulphides, forming cupric and ferric chlorides. The chlorides were dissolved in a subsequent leaching with ferric chloride, which had to be regenerated by the action of chlorine on the ferrous chloride

formed in precipitating the copper. Half the copper in the ore was dissolved within four months, and 86 per cent. of the remainder in the following two years. The pyrite in the ore was unacted on, but in addition to the slowness of the process the costs were excessive owing to the large amount of chlorine lost.

Ex.: At Antwerp, solution tanks are 82 ft. × 11 ft. 6 in. × 11 ft. 6 in. deep, with filter bottom consisting of leached ore and straw. First wash is of heated precipitation liquors which are allowed to remain in contact ten hours; the second is of heated condensing tower liquors further acidified if necessary; the last washing is with hot water. Residues contained only 0.25 per cent. copper.

(iii.) Leaching with ferrous chloride and free hydrochloric acid is practised in the Henderson Process, and is really only a slight modification of the above. It is based on the fact that the result of the oxidation of ferrous chloride in the presence of hydrochloric acid is ferric chloride.

Ex.: At Stadtberge, crushed chloridised ores are leached by means of the mother liquor (containing ferrous chloride), obtained after the precipitation of copper, to which hydrochloric acid has been added. The solution is carried out in false-bottomed tanks of wood with caulked joints, holding five to ten tons of ore, and is complete in three days after twelve or sixteen washes. The false bottom is made of perforated planks upon which is a filter layer of coke, ashes, or straw.

Ex:. At Oker, lixiviation of the chlorides is done in false-bottomed lead lined tanks of five to ten tons capacity by three washes of precipiation liquors (containing ferrous chloride and hydrochloric acid or acid liquors from the condensing towers) and six of water, each wash remaining in contact with the ore for only a few hours. The first washes dissolve 75 per cent. of copper contents. The cuprous chlorides and oxides are dissolved by the acid liquors from condensing towers connected with roasting furnaces or by dilute acid, the solution being allowed to remain in contact with the ore for two days.

Ex.: In Great Britain the leaching tanks, ten feet square and five and a-half feet deep, hold twenty tons of ore, which is washed with acid solutions (obtained by condensation of the gases from roasting the ore), followed by hot water.

Ex.: At Antwerp, the mixture of copper chloride and oxide is first lixiviated with old precipitation liquors and then with solutions of the gases given off during the roasting of the ore. The residue contains 0.25 per cent. copper.

D.—SULPHATE.

The sulphate being easily soluble in water, only one method of solution is necessary.

(*a*) By Water.

Copper sulphate often occurs in mine waters, having been produced by oxidation of the ore exposed in the workings and dissolved by circulating waters.

Ores containing disseminated copper sulphate may be leached in wooden vats, in masonry tanks, or on stamped clay or loam floors. The solutions are circulated, so that the strongest are put on to fresh ore, the weakest into exhausted ore.

Ex.: At San Domingos (and Rio Tinto) when the method of exposing to natural oxidation was employed, the heaps were periodically watered from a pipe reticulation and leached with acid mother liquor containing ferric sulphate (obtained from the precipitation of the copper), which, besides dissolving the copper, accelerated the oxidation of the sulphides. The copper in the residues after six years' treatment amounted to ¼ per cent., which it did not pay to extract; the very large quantity of water required necessitated the construction of immense reservoirs, of one and a-half to five million tons capacity.

Ex.: At Rio Tinto later, the ores after the first roasting were transferred to cement-lined masonry tanks, 100 feet by 34 feet by 5 feet, with false bottoms of perforated planks. The first leaching lasts two to six hours, then there are five or six additional leachings, the ore being left under water eight to ten hours each time. The leached ore then contains ½ per cent. copper, and after decomposition in "terreras" as described is leached during a period of five years, at the end of which time 88 per cent. of the copper has been extracted.

Ex.: At Stadtberge, the copper sulphate formed by the action of nitrous and sulphurous gases is simply leached with water (or the acid liquor from former precipitations).

Ex.: At Agordo, leaching is done in square wooden vats with false bottoms of boards or acid-proof stoneware and filters of straw, coke, &c. The vats have a capacity of up to 200 tons.

E.—SULPHIDE.

The solution of the sulphide, being most difficult of all, is seldom attempted directly, though the action given below does occur.

(*a*) By Ferric Sulphate [$Fe_2(SO_4)_3$].

The "brown liquor" from the precipitation of cement copper by iron from sulphate solutions, after oxidation, consists in part of ferric sulphate. The liquor is reduced, in passing over cupriferous pyrite, to ferrous sulphate and copper is dissolved in proportion to the quantity of iron reduced.

$$Fe_2(SO_4)_3 + Cu_2S + H_2SO_4 = 2CuSO_4 + 2FeSO_4 + H_2S.$$

Or $$Fe_2(SO_4)_3 + Cu_2S = CuSO_4 + 2FeSO_4 + CuS;$$

and $$Fe_2(SO_4)_3 + CuS + 3O + H_2O = CuSO_4 + 2FeSO_4 + H_2SO_4.$$

This action is important in all the sulphatising leaching processes. It is very desirable that no excess of ferric sulphate remain in the solution, as the consumption of iron would be increased by it during the precipitation of the copper thus:—

$$Fe + Fe_2(SO_4)_3 = 3FeSO_4$$

It has been noticed that as the copper content decreases the amount of copper dissolved decreases in greater ratio, though the amount of free acid increases. This is owing to the action of pyrite on the ferric sulphate, and, as it is more energetic with increase of temperature, the large consumption of iron needed to precipitate the copper in solutions from the highly heated roast heaps at Rio Tinto is thereby explained.

Ex.: At Rio Tinto the above action is made use of to dissolve the unaltered sulphides in the roasted (sulphatised) ore.

F.—SULPHITE.

The sulphite is produced in only one process, and its solution then is easy

(*a*) By Sulphurous Acid.
(Neill's Process.)

The sulphur dioxide besides forming sulphite in this process is necessary to keep that salt in solution. (*See* under "Preparation" and "Precipitation.")

IV.—Precipitation of the Copper or Copper Salt from Solution.

1.—BY METALLIC IRON.

The reduction of the copper, which, as shown above, is in solution in the form of sulphate or chloride (cupric or cuprous), is generally brought about by means of metallic iron.

$$CuSO_4 + Fe = Cu + FeSO_4;$$
$$CuCl_2 + Fe = Cu + FeCl_2;$$
$$2CuCl + Fe = 2Cu + FeCl_2.$$

(*a*) Reduction from Solution.

Theoretically: 88.8 parts of iron precipitate 100 parts of copper from cupric solutions, and 44.4 parts of iron precipitate 100 parts of copper from

cuprous solution, but in practice, with sulphate solutions, 200 to 300 parts of iron may be required to precipitate 100 parts of copper. This is owing to the presence of ferric salts and free acid, the latter from the oxidation of pyrite as already shown, and the former from the oxidation of ferrous salts.

$$2FeSO_4 + H_2SO_4 + O = Fe_2(SO_4)_3 + H_2O.$$
$$3FeCl_2 + H_2O = Fe_2Cl_6 + FeO + H_2.$$

Both the acid and the ferric salts attack metallic iron, and it is therefore necessary that the solution should be as free as possible from them.

$$H_2SO_4 + Fe = FeSO_4 + H_2;$$
$$Fe_2(SO_4)_3 + Fe = 3FeSO_4.$$

The latter may be reduced by filtering the liquid through copper sulphide ores, as shown under "Solution of the Sulphide (E.)" and in the following equation :—

$$7Fe_2(SO_4)_3 + FeS_2 + 8H_2O = 15FeSO_4 + 8H_2SO_4.$$

Basic salts render the cement copper impure, and it is therefore advisable to allow the solutions to work on the ores till neutral.

The iron is used in the form of wrought iron, pig iron, sponge and bar iron. Powdered iron, turnings, and clippings act most rapidly. Bar iron and grey pig give a coarse pulverulent cement, while white iron throws down coherent copper.

The deposition of the copper is accelerated by heating the solution (by steam or hot air, the latter in Waterbury's Patent), by agitating it (by mechanical stirrers, by a current of air, or by circulation from vat to vat), and by increasing the surface of the iron exposed to the liquid.

The "cement" (the copper precipitate), owing to its commuted and bulky state, is extremely liable to oxidation, so that it seldom contains over 80 per cent. copper when delivered to the smelters.

Any silver in solution, unless previously precipitated by sulphuretted hydrogen, potassium iodide, or alkaline sulphides, goes down on the first of the copper reduced. It may be precipitated as iodide by the addition of sufficient zinc iodide, which is regenerated by the action of metallic zinc on the silver iodide (as in the Claudet Process).

Antimony and arsenic are also deposited with the copper, and, together with the graphite of the pig, particles of iron, and silica, tend to render the "cement" impure. These impurities occur chiefly in the finer portion of the precipitate, which is thrown down as the solution becomes poorer in copper.

The use of pig and scrap iron is not to be thought of for our inland deposits because of the heavy freights. The difficulty might, however, be obviated by the use of ground sponge iron produced locally. This material has given fairly good results in England, though, owing to the large quantity of impurities, it could not compete with scrap iron. It is produced by heating, at a full red heat, a mixture of coke dust (or possibly charcoal), 6 cwt., and purple ore (the residue from the copper leaching vats), one ton, in a special reverberatory furnace, for from nine to twenty-four hours, according to the position of the ore on the hearth. An intense heat is not required for the reduction, and fusion does not take place. After heating the material is drawn from the furnace into cast iron vessels, which are hermetically sealed till cold. The sponge is then ground under edge runners.

Ex.: Mine waters containing copper sulphate are known as "cement" waters. They are run through a system of troughs inclined at angles of about 10 degrees, arranged in steps, and filled with iron or crossed by iron gratings.

Ex.: At Wicklow, Ireland, the water is conducted through troughs, inclined 7 degrees to 10 degrees, opening at intervals into tanks. Iron in the troughs precipitates the copper, which is washed into the tanks, and there collected.

Ex.: Cornwall Mines.

Ex.: Mount Morgan.

Ex.: At San Domingos copper was precipitated by pig iron stacked in asphalted basins 13 feet square, of which there were 240. The iron consumed was double the weight of the copper precipitated owing to ferric sulphate in the liquors. The cement, containing 65 per cent. copper, after drying was exported.

Ex.: In the Old Hunt and Douglas Process only sixty to seventy parts of iron are required for 100 parts of copper, because of the copper being in the cuprous form, and the cement is unusually pure. Precipitation is rapid, and, the solutions being reused, it is not necessarily complete for each cycle. Solutions are, therefore, not exposed long, and only small quantities of basic salts are formed.

$$2CuCl_2+2CuCl+2Fe=4Cu+Fe_2Cl_6.$$

Ex.: At Rio Tinto, the sulphate solutions pass from settling tanks into a series of cemented or asphalted masonry tanks 50 feet long, 6 feet wide, and 3 feet deep; and from the tanks the solution runs through inclined masonry troughs 3 feet 3 inches to 6 feet 6 inches wide and 1 foot 4 inches to 1 foot 8 inches deep for several miles, with an inclination of 0.3 per cent. at first to two per cent. towards the end. Both tanks and troughs are loosely filled with iron. The consumption of iron has been very high ($2\frac{1}{2}$ tons for each ton of copper precipitated), owing to the formation of ferric salts, and the cement is rendered very impure (containing only 60 to 85 per cent. copper), owing to the precipitation of basic iron salts.

In the natural oxidation process, the solutions have required two tons of iron per ton of copper, and the cement contained only 65 per cent. copper. By careful previous reduction of the ferric salts, and by regulating the velocity of the solutions in the precipitating tanks, it has been found possible to reduce the consumption of iron to 1.4 tons per ton of copper precipitated.

In the ferrous sulphate roast modification, the consumption of iron is equal to the weight of the copper precipitate.

Ex.: At Stadtberge, 127 parts of iron are required to precipitate 100 parts of copper. At these works the silver is precipitated with a little copper in the first tank, the remaining copper, free from silver, being thrown down in other tanks. Green vitriol ($FeSO_4$) is also produced from part of the resulting solutions

Ex.: At Oker, the solutions are heated in lead-lined wooden tanks, and the copper is precipitated in from one to three days by means of wrought-iron (in the proportion of one part to each part of pure copper).

Ex.: At the Bede Metal Works, England, ground iron sponge is employed as a precipitant, but, as it contains unreduced iron oxide, ashes, and coal, its use has not been extended.

Ex.: At Natrona, Pennsylvania, the precipitation of the copper on thin iron, in false-bottomed tanks, is hastened by the injection of steam, which, besides heating the solution, mechanically keeps the iron free of copper. The cement produced here contains 90 per cent. copper.

Ex: At the Antwerp Works, cupric chloride is reduced in twenty-four hours by scrap iron (equal in weight to the copper produced), in seven nine-ton vats, in which the solution is heated. The cement contains 80 to 88 per cent. copper. The residues are sold to iron works.

Ex.: In Great Britain, precipitation in the Henderson-Claudet Process is by scrap iron (110 parts to each 100 of copper), in a solution kept at 150 degrees by the injection of steam. The cement produced contains 75 per cent. copper.

(*b*) Reduction of Solid.

(New Hunt and Douglas Process.)

The solid cuprous chloride may be reduced under water by metallic iron—one-half the weight of the copper precipitated. Silver in the ore having been converted into chloride may be extracted from the residue.

Ex.: At Kansas City.

2.—BY VOLATILISATION OF THE SOLVENT.

(Neill's Process.)

Copper sulphite in solution in sulphurous acid is readily precipitated as a red crystalline solid ($CuSO_3.Cu_2SO_3.2H_2O$), containing 49.1 per cent. copper, by simply driving off excess of sulphur dioxide. This is done in a wooden tank by heating to boiling by waste steam in a pipe coil. The slight amount of copper then remaining in solution is readily precipitated by lime (or iron), in separate tanks, preferably, while the solution is still hot. The plant may be so arranged that nearly all the sulphur dioxide except that combined with the copper can be saved and reused.

This process deserves very serious consideration by Queensland mine-owners, as the great expense of freight on the iron needed for most of the other processes is here entirely obviated.

3.—BY SULPHUROUS ACID.

(*a*) To Metal.

(Van Arsdale's Process.)

This process, which has not yet, as far as known, been put into actual practice, depends on the fact that sulphur dioxide under certain circumstances precipitates part of the copper from cupric sulphate solution, and at the same time generates sulphuric acid.

$$3\,CuSO_4 + 3\,SO_2 + 4\,H_2O = Cu_2SO_3.CuSO_3 + 4\,H_2SO_4$$
$$= Cu + 2\,CuSO_4 + 2\,H_2SO_4 + 2\,SO_2 + 2\,H_2O.$$

These reactions take place in a boiling solution under ordinary atmospheric pressure, but when under increased pressure the yield of copper is raised to from 40 to 50 per cent. of the contents.

The solution, after separation from the ore, which needs careful washing, is allowed to drain through a tower packed with coke, &c., and exposed to the action of sulphur dioxide from burning pyrite. It is then heated by steam to 100° C. in a lead-lined steel tank, similar to a chlorination barrel, to cause a pressure of 30 lb. per square inch and the precipitation of 50 per cent. of the copper contents.

(*b*) To Chloride.

(New Hunt and Douglas Process.)

Cuprous chloride is precipitated from solution by the reducing action of sulphurous acid gas, sulphuric acid being regenerated at the same time:

$$CuCl_2 + CuSO_4 + SO_2 + 2H_2O = 2CuCl + 2H_2SO_4.$$

The precipitate is readily separated from the liquid, and is then reduced by metallic iron.

Into the solution decanted from the cuprous chloride hot air is blown to expel any sulphur dioxide or oxidise it to sulphuric acid for use again in leaching.

The amount of zinc and iron in solution gradually increases, these metals not being precipitated by sulphurous acid, and they may therefore be saved as well as the copper.

Ex.: At Kansas City, sulphur dioxide is passed through cupric chloride solution to precipitate cuprous chloride—

$$2CuCl_2 + SO_2 + 2H_2O = 2CuCl + H_2SO_4 + 2HCl.$$

The same reactions as above occur in Hoepfner's Process.

4.—BY MILK OF LIME (CaH_2O_2).

(New Hunt and Douglas Process.)

Milk of lime precipitates copper hydroxide from cupric chloride and cuprous oxide from cuprous chloride solutions, the solution obtained being available for chlorinating a fresh charge. In the case of copper sulphate, calcium sulphate is precipitated with copper hydroxide, and the use of lime is therefore prohibited. The bulk of the precipitates and the difficulty in smelting them have hitherto been considered deterrents, but it would probably be much cheaper to employ lime than iron at many of our inland copper deposits, there being generally deposits of limestone in the vicinity, from which the lime could be prepared.

Ex.: At Kansas City.

5.—BY SULPHURETTED HYDROGEN (H_2S).

This gas is only to be used when iron is not available. It may be produced by passing sulphur dioxide gas (from the calcination of pyrite), together with water vapour, over red-hot coke or charcoal, or by forcing the same gas by a steam jet through glowing charcoal in a shaft furnace, alternately with air, to keep the fuel burning, as in the production of water gas.

$$SO_2 + 3C + H_2O = H_2S + 3CO.$$

Sulphuretted hydrogen may be prepared by leading producer gas (from raw fuel) over red-hot pyrite.

$$2FeS_2 + 4H_2O + 2CO + O = 4H_2S + F_2O_3 + 2CO_2.$$

The product of precipitation by sulphuretted hydrogen is copper sulphide (CuS) containing 66 per cent. sulphur and equivalent to a high-grade ore.

Ex.: Precipitation by sulphuretted hydrogen was formerly practised in Norway and Spain.

Ex.: At the Bede Metal Works, where sulphuretted hydrogen was employed for a time, the process cost more than precipitation by iron, and was therefore abandoned.

6.—BY ELECTROLYSIS.

It has been proposed to precipitate copper from its solutions by electricity, but the expense prohibits it, one horse-power per hour precipitating only $\frac{1}{4}$ lb. copper at a cost of 1.71d. per lb., while, in the case of refining, $2\frac{1}{2}$ lb. are precipitated at a cost of only 0.27d. per lb.

Owing to the expense of electricity in Queensland, due to the absence of cheap natural power, electrical precipitation may be dismissed from consideration.

V.—Treatment of the Copper Precipitates.

1.—CEMENT COPPER.

The generally impure bulky incoherent metal deposited on metallic iron is washed as free as possible of basic iron salts, metallic iron, graphite, silica, antimony, and arsenic. It is then, if containing more than 55 per cent. copper, refined direct, or else smelted in a reverberatory furnace for blister copper, and then refined; but if very impure, containing less than 15 per cent. copper, it is smelted for matte with the addition of raw ores.

Ex.: At Stadtberge, the washer, treating five tons of "cement" in ten hours, is a wooden drum 10 feet long and 4 feet in diameter, provided with an internal spiral cleat. A stream of water passes through the drum in the opposite direction to the copper, and, as a result, two-thirds of the copper contents are obtained (assaying 90 to 95 per cent.). The slimes, containing 10 to 25 per cent. copper, are agglomerated with lime and smelted.

Ex.: At Antwerp, the cement copper is washed on iron sieves with water, under a pressure of two atmospheres, to dissolve soda sulphate. The cement is then, to prevent oxidation, pressed into cakes in a hydraulic press, under pressure of fifty atmospheres.

The copper obtained in Van Arsdale's Process simply needs to be melted down. It may, however, contain precipitated salts of iron and other impurities, and would then have to be smelted.

2.—COPPER SULPHITE.

(Neill's Process.)

The sulphite, after washing and drying, is reduced to metallic copper by fusion in a reverberatory furnace or in a crucible, practically without fluxes and without the formation of a slag. The copper produced is pure, and free from gold and silver.

3.—CUPRIC OXIDE.

(New Hunt and Douglas Process.)

Reduction to metal is brought about by smelting with charcoal, and refining if necessary.

4.—COPPER SULPHIDE.

(From Precipitation by Sulphuretted Hydrogen.)

The precipitate is washed, compressed in a filter press, and reduced in reverberatory furnace.

VI.—Details.

1.—PLANT.

(*a*) General.

As each separate plant differs so greatly from every other, the dearth of detailed information regarding those in operation is to some extent explicable. The example given below is of one of the most important works in the United States.

Ex.: At Natrona, where 200 tons of ore are treated per day, fourteen muffle furnaces (capacity 12 tons in three charges per twenty-four hours) are in operation, and one is held in reserve, all being connected with condensing towers.

The following diagrammatic plans of the arrangement of the plant at these works are from Vol. VIII. of the "Mineral Industry":—

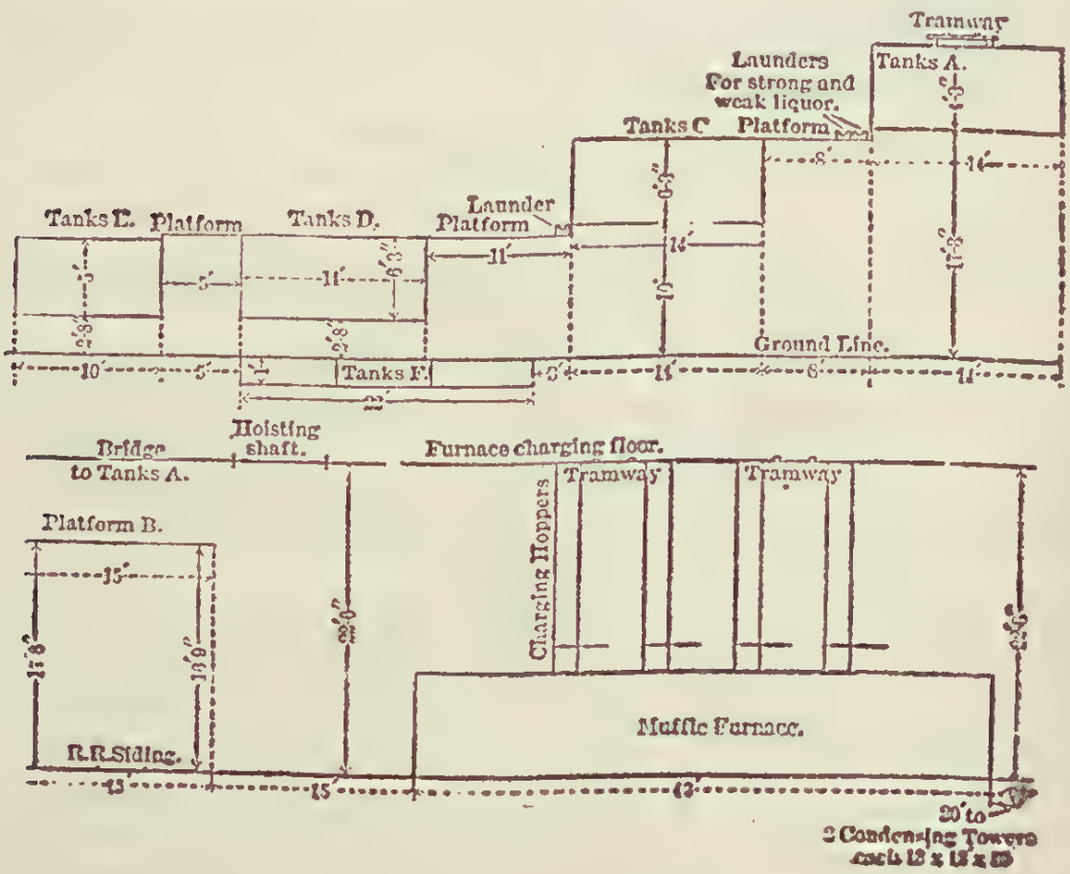


Fig. 1.—End Elevation Leaching Plant, Natrona.

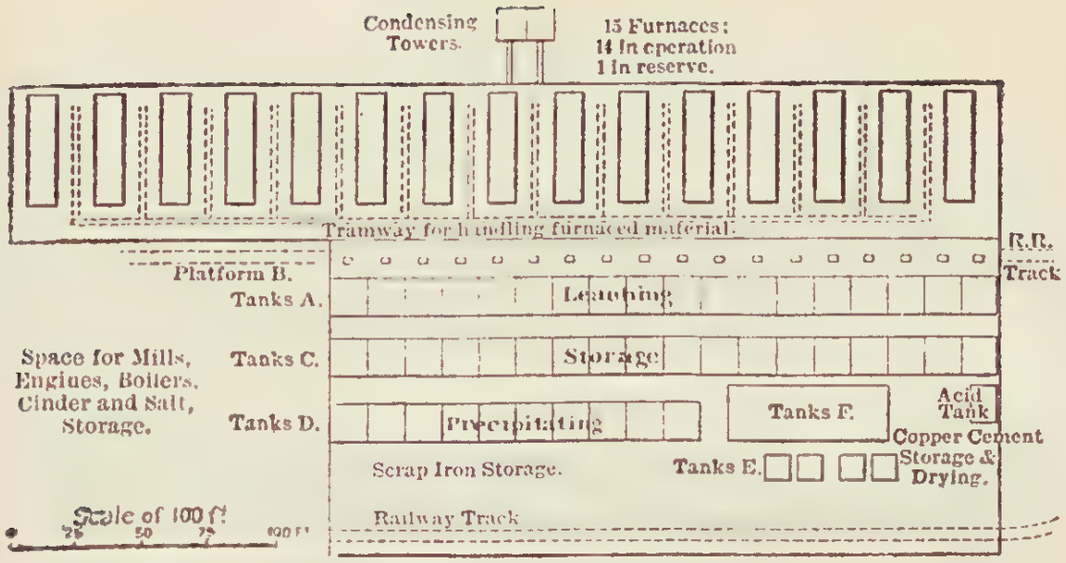


FIG. 2.—GENERAL PLAN OF LEACHING PLANT, NATRONA.

The leaching tanks are eighteen in number, each 14 feet × 4 feet 3 inches deep; the settling and storage tanks, eighteen in number, are each 14 feet × 14 feet and 6 feet 3 inches deep; the precipitation vats, ten in number are each 10 feet × 14 feet and 6 feet 3 inches deep; and the "cement" washing tanks, fourteen in number, are each 10 feet × 10 feet, and 5 feet deep. There is, in addition, a series of tanks for the last precipitation of waste liquors. Space has to be allowed for engines, boilers, cinders, salt, scrap iron, and cement, and for the hoist from muffles to the tanks.

Ex.: At Antwerp, two boilers and an engine furnish 50 N.H.P. to various machines and pumps. There are twnty-four solution tanks, each 82 feet × 11 feet 6 inches and 11 feet 6 inches deep.

It is stated in the "Mineral Industry" for 1893 that the cost of a wet extraction plant is four times that of smelting plant of similar capacity. This is speaking of the Henderson Process in particular. The plant for Neill's or Van Arsdale's Process should not cost more than that of a smelter. The cost of a cyanide plant to treat 1,000 tons a month may be taken, for purposes of comparison, as £2,000.

(*b*) VATS AND TANKS.

(i.) *Materials.*—Vats and tanks may be constructed of masonry, iron, or timber, provided that in each case protective materials (cement, lead, red lead, tar, paraffin, clay, &c.) be also used. The disadvantages of masonry are the impossibility of detecting leakages, and, in the case of a subsidence of the foundations, the difficulty in rendering the tanks tight again. By the exercise of the utmost care in construction, however, these give every satisfaction, as at Mount Morgan, where used in the chlorination of gold ores.

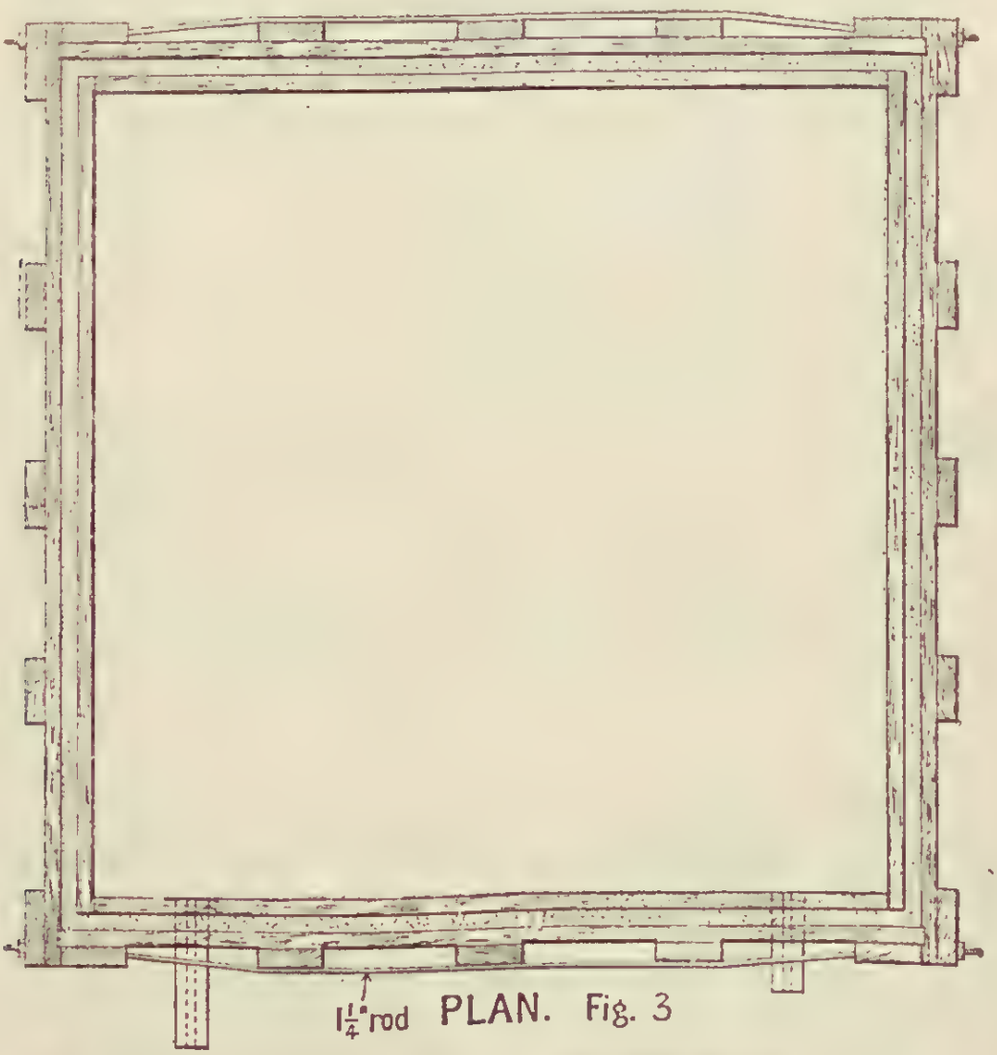
Though iron vats are preferred to wooden ones for cyaniding in the United States, it is probable that the difficulty in protecting iron against the cupreous solutions would necessitate the use of wood or masonry for copper leaching, and the last having been put out of count we must look to timber for the necessary materials.

The corrosive action of the leaching liquors and the consequent heavy repair bill are the main things to be kept in view in designing vats. Wooden pins only may be used, and all supporting timbers, planks, and pins should be tarred on all sides before erection.

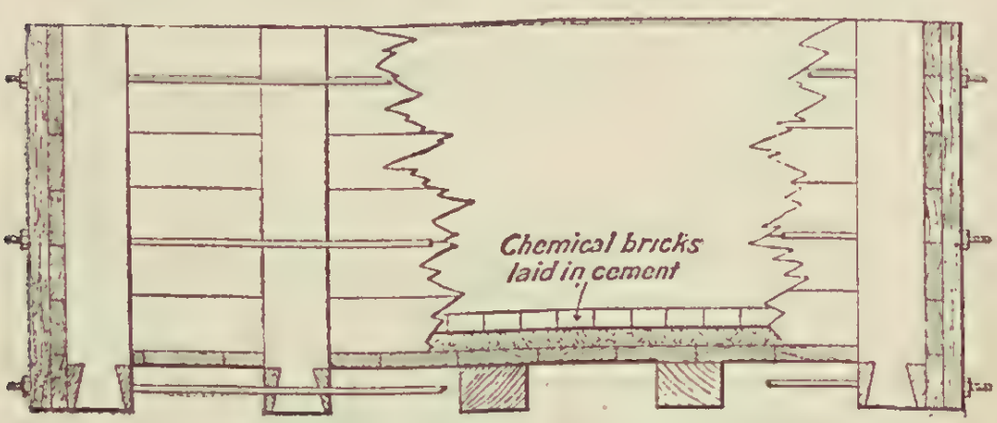
(ii.) *Dimensions.*—Circular vats are preferred to rectangular ones for cyanide work, because of the greater ease in keeping them free from leaks, and because of their greater strength. The sides of tanks, from 14 to 20 feet in diameter and from 4 to 14 feet deep, are constructed of 5 by 2½ inch or 6 by 3 inch planks, while the bottom is made of 12 by 3 inch planks, rebated into the side. The side planks are kept in place by the pressure of ¾ to 1¼ inch diameter iron hoops, provided with turn buckles, and placed 15 to 18 inches apart. The cost of a 100-ton vat is £42, and of a 500-ton vat £120.

The comparative weakness of the square vat has to be overcome by greater solidity.

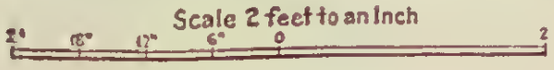
Ex.: At Natrona, the tanks are constructed of outer and inner shells of three-inch plank (tarred inside and out), separated by a space of three inches, which is filled in with a composition of sand and tar. A three-inch layer of the same composition is used on the floor of the tank, and protected from wear by a layer of chemical brick. The solutions are drawn off through six-inch square wooden blocks, bored and provided with plugs.. The leaching tanks are 12 feet × 12 feet and 4 feet deep, the settling tanks 12 feet × 12 feet and 6 feet deep, and the precipitating tanks 12 feet × 12 feet and 6 feet deep. In the first, 2-inch × 2-inch wooden slats are laid on the bottom, and covered with hay or coke. The plans given below are taken from an article by Joel G. Clemmer, in Vol. VIII. of "Mineral Industry." The two sides shown without tension rods are supported by adjacent tanks. (*See* Figs. 3 and 4.)



PLAN. Fig. 3



SIDE ELEVATION & SECTION. Fig. 4.



LEACHING TANK.

Covered vats are recommended for Neill's Process. Those formerly used for chlorination held two to three tons of ore, and were 7½ to 9 feet in diameter and three feet deep. They were built of 2-inch plank, with 2½ by 3¾ inch battens over the joints outside, the whole being covered with three coats of tar. The sides had a batter of 1 in 12.

Cast-iron vats mounted on trunions, so that the contents can be tilted into waste vats, have been used for treating ores of the Black-Warrior Group of Mines in Arizona, U.S.A.

(iii.) *Filters.*—The leaching vats have false bottoms formed of slats, and perforated planks or acid-proof slabs of stone, upon which is a filter of straw, brushwood, or coke.

For cyaniding, frames have superseded sand and gravel beds. They consist of narrow laths one inch apart with transverse laths forming spaces one inch square, and in large vats made in sections. On this frame strong hessian, canvas, cocoa matting, or burlap is used, and kept in position by a rope passing round the circumference of the vat outside the frame.

(*c*) Foundations.

It is imperative that there shall be free access to the bottom of the vat, whatever the foundation, in order that any leaks may be detected and repaired.

Supports for a 70-ton circular vat, 20 feet in diameter and 7 feet high, consist of horizontal mud sills 15 inches by 6 inches (if a rock outcrop is unavailable), sole pieces 10 by 8 inches, supporting uprights 8 by 8 inches, spaced 4 feet centres, with braces 10 by 8 inches, on which the vat rests.

Steel vats up to 25 feet in diameter and 6 feet high are mounted on wooden foundations, supported 2 feet 6 inches from the ground by 8 by 6 inch bearers, 3 feet centres, resting on 6 by 6 inch uprights, with diagonal braces 4½ by 3 inch. Sills and mudsills are of 8 by 6 inch timber.

At Natrona, the ground beneath the tanks is dug up, and filled in, to a depth of two feet, with concrete, to prevent loss by soakage of the leakage from the tanks; and this also serves as a ground foundation for the timbers.

2.—ROASTING.

The object of roasting is to remove part or all of the sulphur, and as much as possible of the arsenic and antimony.

(*a*) Heap Roasting.

The disadvantages of heap roasting are the great quantities of fumes polluting the air and the large amount of ore necessarily locked up to produce a given output. Thus, 240-ton heaps, requiring eighty days' treatment, yield only three tons a day, so that 8,000 tons have to be roasting to keep up an output of 100 tons a day.

In selecting a site for the heaps, drainage has to be kept in mind, and the ore is, if possible, to be protected from high winds causing too fierce combustion.

The heap is built in the shape of a truncated pyramid, on a bed of fuel 8 inches to 15 inches thick. The coarser material in the lower and central parts is surrounded by medium-sized ore, and covered by fines. Flues for draught are left in the layer of firewood, and connect with stacks rising through the ore. The height of the heap (from 5 feet 6 inches to 8 feet 6 inches as a rule) varies inversely as the percentage of sulphur in the ore.

The ore is run from the mine on an overhead tramway, and when roasted may be loaded directly into a truck running in a cutting beside the heap.

The cost of heap roasting varies from 2s. to 4s. per ton.

(*b*) Stall Roasting.

The output may be greatly increased with very little extra cost by roasting in stalls connected with a central stack conveying fumes to the higher air. Each stall may hold 20 tons of ore requiring only ten days to roast, so that the output is two tons per day per stall. Therefore, 1,000 tons roasting in 50 stalls will produce 100 tons a day.

The stalls, $8\frac{1}{2} \times 6\frac{1}{2}$ feet and 6 feet high, are arranged back to back, but separated by the main flue, 2 feet in diameter and 3 feet high, with which they are connected.

(*c*) Furnace Roasting.

(i.) *Burner.*—Pyrite burners are used almost exclusively in works for the manufacture of sulphuric acid, the object being to obtain the sulphur dioxide free from carbonaceous gases. Little or no carbonaceous fuel is used, and, the process being continuous, only enough air to oxidise the sulphur is admitted. The pyrite layer is 18 inches to 2 feet deep.

(ii.) *Muffle Furnace.*—A plan and elevations are given here from Phillips and Bauerman's "Elements of Metallurgy."

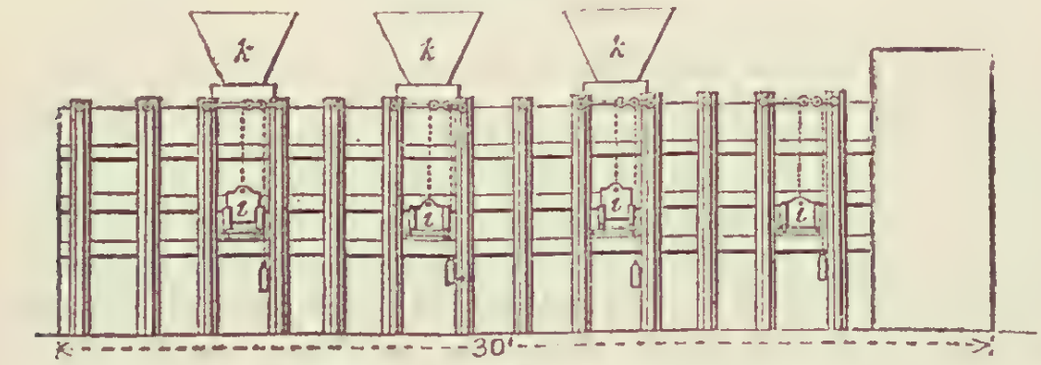


Fig. 5.—Muffle Furnace, Longitudinal Elevation.

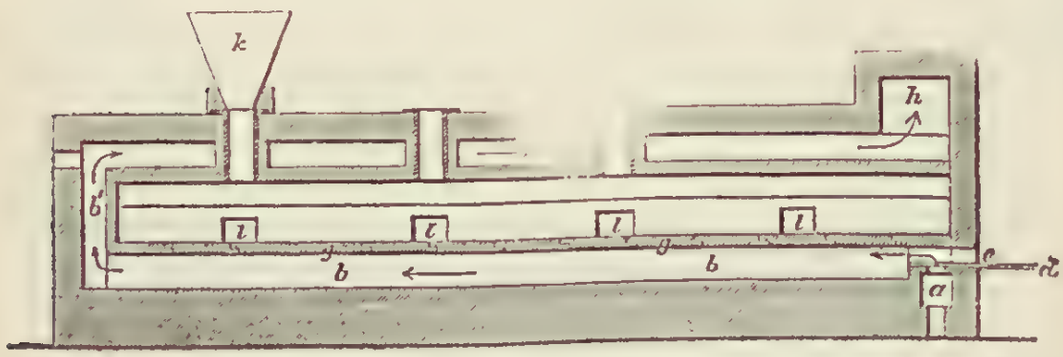


Fig. 6.—Muffle Furnace, Longitudinal Section.

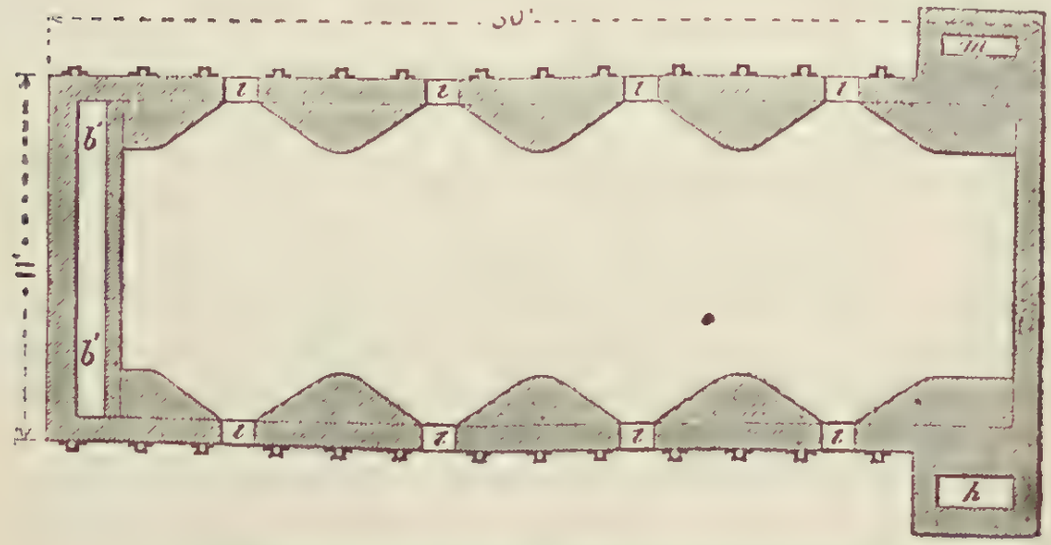


Fig. 7.—Muffle Furnace, Horizontal Section through Working Doors.

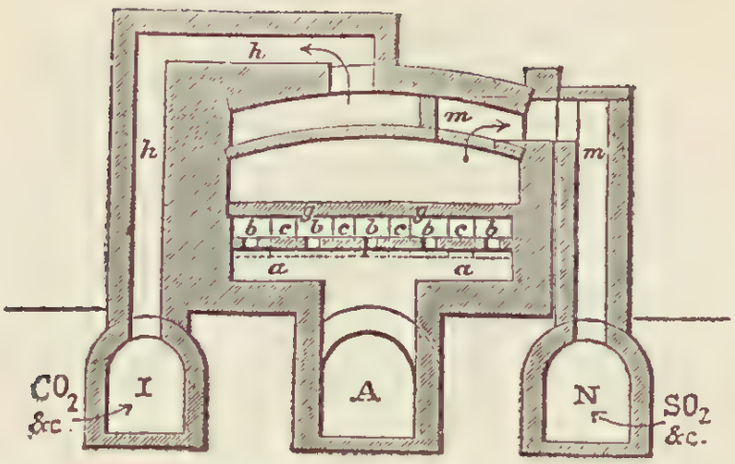


Fig. 8.—Muffle Furnace, Transverse Section through Working Doors.

This is designed for the use of gaseous fuel, but it would require very slight modification for the use of solid fuel. The charge amounts to 3¼ tons, and the roast requires six hours.

(iii.) *Hand Reverberatory Calciners.*—These may be either open hearth or muffle. The cost of a reverberatory furnace, putting through 13 tons a day, is £600, and the cost of calcination, reducing the sulphur from 40 per cent. to 7 per cent., is 7s. per ton.

(iv.) *Automatic Calciners.*—Automatic calciners are chiefly used where labour and fuel are dear, their construction and maintenance being costly—

(*a*) Straight hearth: Ex.: "Ohara" and "Spence"; cost of furnace, about £1,200; and cost of calcination, 2s. per ton.

(*b*) Annular hearth: Ex.: "Pearce Turret" and "Horseshoe"; cost of furnace, about £1,100; and cost of calcination, 2s. 3d. per ton.

(v.) *Revolving Cylinders.*—(*a*) Continuous discharge: Ex.: "Howell-White"; used in South Australia and at Mount Morgan. (*b*) Intermittent discharge: Ex.: "Brückner."

(vi.) *Shaft Furnace.*—Ex.: "Hasenclever," a combination of stack and reverberatory furnace used in pyrite burning. The ore falls from side to side down a shaft up which heated gases from the reverberatory pass, and the sulphur being reduced from 10 per cent. to 3 per cent.

3.—WORKING COSTS.

In Vol. II. of the "Mineral Industry" (1893) it is stated, but without further particulars, that the cost of the Henderson Process is 29s. per ton of cinder containing 4 per cent. copper, as against 10s. 6d. by smelting, though the copper saved is as 3.7 is to 3.1. The silver, however, from the wet process has a greater value than that in the matte, and the value of the purple ore residue from the wet process was not considered.

In contradistinction to this, it is stated in Vol. VIII. of the same publication (1899) that the cost by the modification of Henderson's Process used at Natrona, Pennsylvania, is only 7s. 9½d. per ton of ore treated.

Eissler gives the cost of treatment at Rio Tinto at £20 per ton of copper, which is equivalent to 10s. per ton of ore treated.

Ex.: At Rio Tinto, ores yielding only 1½ per cent. copper have been treated at a profit, with the price of copper at £50 a ton.

	£
1 ton of copper is produced from 66⅔ tons of ore—	
Wet treatment for 66⅔ tons of ore at 3s. per ton	10
Mining, 66⅔ tons of ore at 3s. per ton	10
Total expenses per ton of copper produced	20

Leaving a profit of £30 per ton of copper produced, or 9s. per ton of ore treated. These figures are, however, altogether exceptional, and only serve to show what the possibilities are.

The cost of leaching in vats will vary according to the locality, the ore treated, and the size of the plant, and will probably compare with cyanide treatment, which averages about 3s. per ton.

Ex.: At Rio Tinto, the following are the costs by the sulphatising process (Eissler):—

	s.	*d.*	
Mining	3	2½	per ton ore
Roasting	0	8½	„ „
Cementation	2	3	„ „
	6	2	„ „

With copper at £50 per ton, a two per cent. ore will yield copper valued at £1, leaving a profit of 13s. 10d. per ton.

Ex.: At Rio Tinto, the following were the costs by the Dotsch process:—

	£	*s.*	*d.*	
Lixiviation	3	7	0½	per ton of cement proper
Precipitation	7	4	11	
General Expenses ...	1	2	5	
	£11	14	4½	
Equivalent to	13	16	0	per ton of pure copper,
or	0	3	8	per ton of ore treated.

Ex.: At Natrona, where 200 tons of ore and salt are treated daily, the cost of treatment is £70 9s. 4d., equivalent to 7s. 11d. per ton of pyrite. The men employed include: two engineers, one mechanic, three firemen, two samplers, and six mill men; four weigh-men and furnace charges, twenty-eight furnace men, one hoist man, twenty-seven furnace material handlers and wheelers, two leachers, and four copper precipitators.

Ex.: At Antwerp, 96 tons of ore and 24 tons of salt are put through per twenty-four hours, at a cost of £1 6s. 8d. per ton of ore, which is bought for 3s. 4d. per ton. Ninety-six tons of ore produce three tons "cement" (equivalent to 2·47 tons copper), valued at £160 10s. with copper at £65.

Expenses of treating, £128; total profit, £32 10s.; and profit per ton of ore, 6s. 8d.

The employees include: one general manager, three superior officials, ten overseers, mechanics, blacksmiths, and carpenters; twelve men in crushing department; twenty-eight men at roasting furnaces; twelve men at precipitation vats; ten chargers; eight loaders of purple ore; sixteen maintaining material; and forty-three general hands. Total, 143.

VII.—Summary.

BRIEF DESCRIPTION OF COMPLETE PROCESSES.

1.—Atmospheric Oxidation.

(Rio Tinto.)

Sulphides are exposed in heaps, leached with water and iron sulphate liquors (from the precipitation vats), and the copper precipitated in vats by iron.

2.—Slow Roast.

The process is the same as No. 1, except that the heaps are roasted before leaching.

3.—Ferrous Sulphate Roast.

Differs from the above (No. 2) only in that ore is roasted with ferrous sulphate.

4.—Neill's Process.

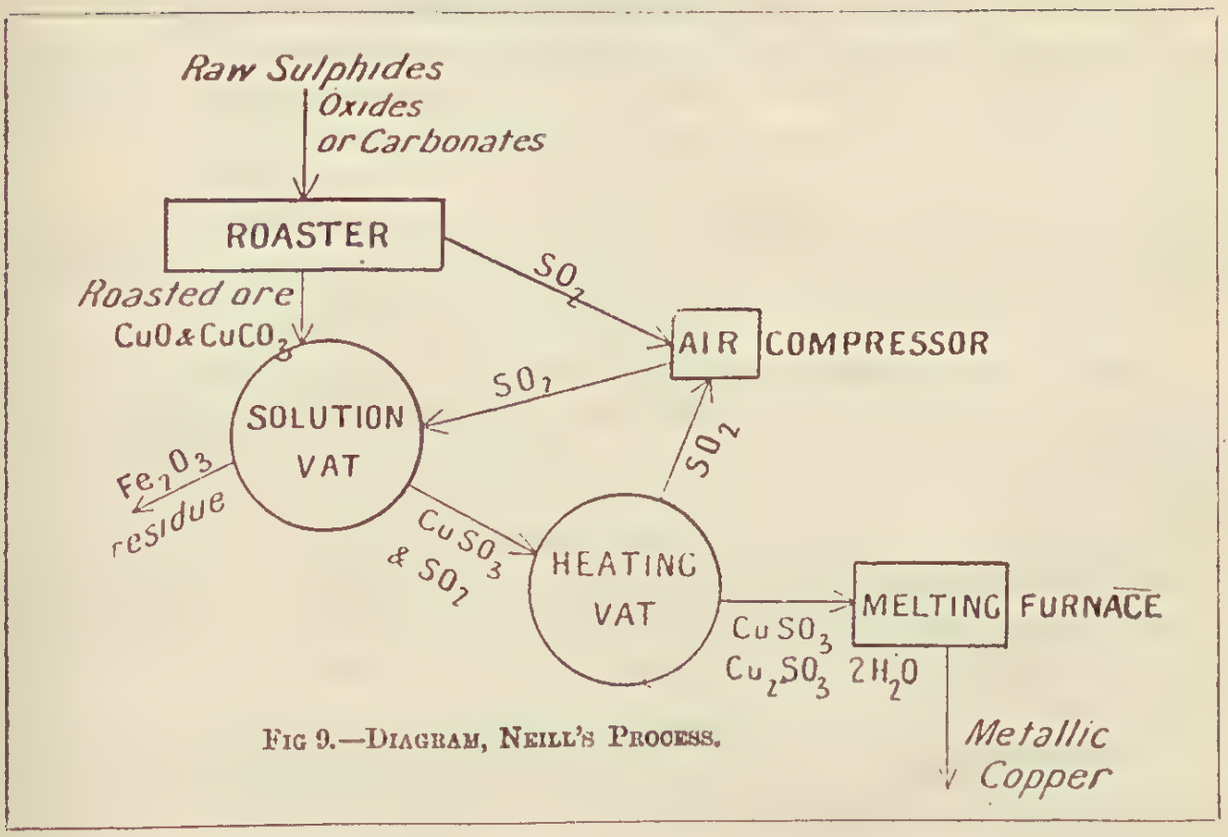


Fig 9.—Diagram, Neill's Process.

5.—Henderson's Process.

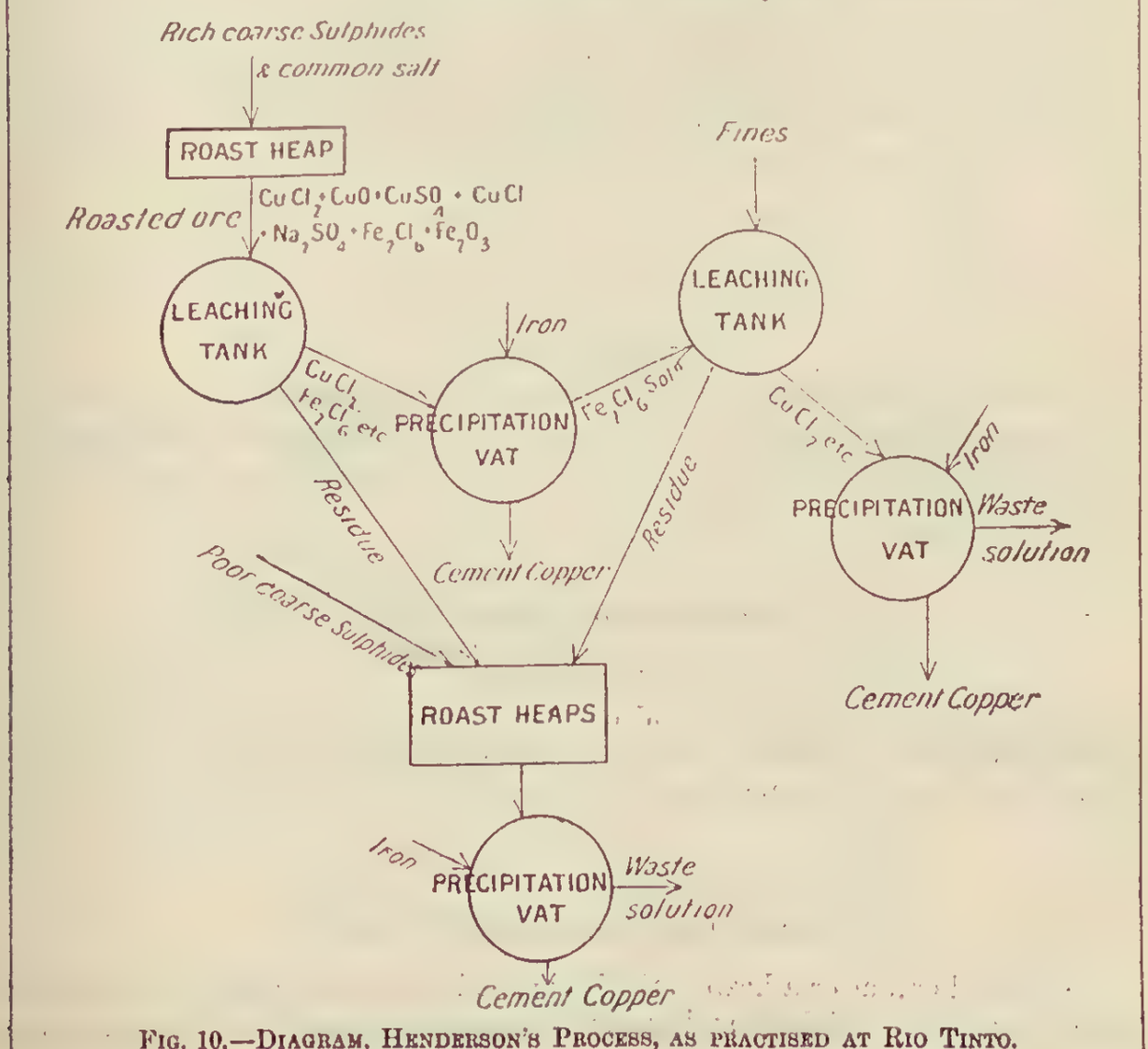


Fig. 10.—Diagram, Henderson's Process, as practised at Rio Tinto.

Modification (Rio Tinto).—Residues from sulphuric acid manufacture are roasted with common salt; the chlorides, oxides, and sulphate are then leached out with water and acid liquors from the precipitation tanks. The sulphide-bearing residue is allowed to oxidise while covered with sulphides mixed with common salt and manganese dioxide to produce copper chlorides, which are reduced with iron.

Modification (Rio Tinto).—The ferric chloride from the roast heaps is used for leaching the sulphide fines, forming cupric chloride, which, after the solutions have settled, is precipitated in the ordinary way.

Modification (Oker).—Sulphides, after an oxidising roast in pyrites burners, are further roasted with common salt in a gas furnace: the chlorides and sulphate are leached out with water in vats, and the copper precipitated in separate vats by metallic iron.

Modification (Antwerp).—Sulphide fines are roasted with common salt in a muffle furnace, and the sulphurous and chlorine gases given off, after condensation and absorption by water in a tower, are used for leaching together with the acid liquors from the precipitation vats. The cupric chloride is reduced by iron.

Modification (Natrona).—The burnt pyrite is roasted with common salt in a muffle furnace, and leached in vats with water, and the condensed gases given off during the roast. Precipitation from the cupric chloride is by iron.

Modification (Combination with Claudet Process).—The silver in solutions from the leaching vats is precipitated by the addition of zinc iodide, and the copper, free of silver, is then reduced from the chloride solutions with iron.

Modification (Dotsch Process).—The pyrite fines are leached in heaps with ferric sulphate and common salt and ferric chloride (produced by the action of chlorine on ferrous chloride). Precipitation is by iron, ferrous chloride being formed at the same time.

6.—Sulphuric Acid Process.

(Stadtberge.)

Carbonate ores are leached in tanks with acid formed by the combination of water, sulphur dioxide (from pyrites burners), and nitrous oxides (from a nitre furnace), together with the acid liquors from the precipitation tank, where copper is reduced by iron.

7.—Hydrochloric Acid Process.

(Stadtberge.)

Agrees with the sulphuric acid process in all except that hydrochloric acid replaces sulphuric, and that the silver is precipitated on the first of the copper throw down, and is thereby saved.

8.—Old Hunt and Douglas Process.

Oxidised ore, after a heap roast, is agitated with ferrous chloride, produced by mixing ferrous sulphate and common salt, and also by precipitation of the copper by iron.

9.—New Hunt and Douglas Process.

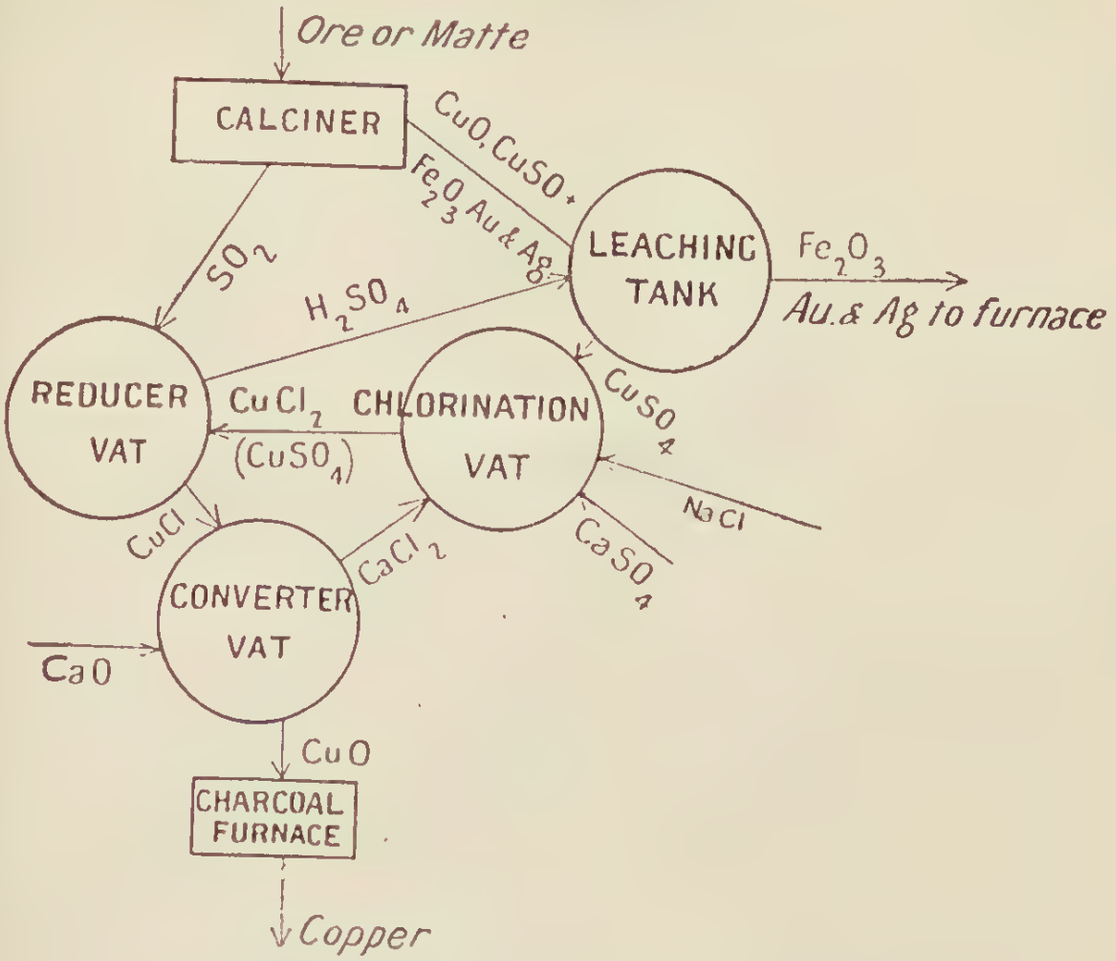


Fig. 11.—Diagram, New Hunt and Douglas Process.

10.—Van Arsdale's Process.

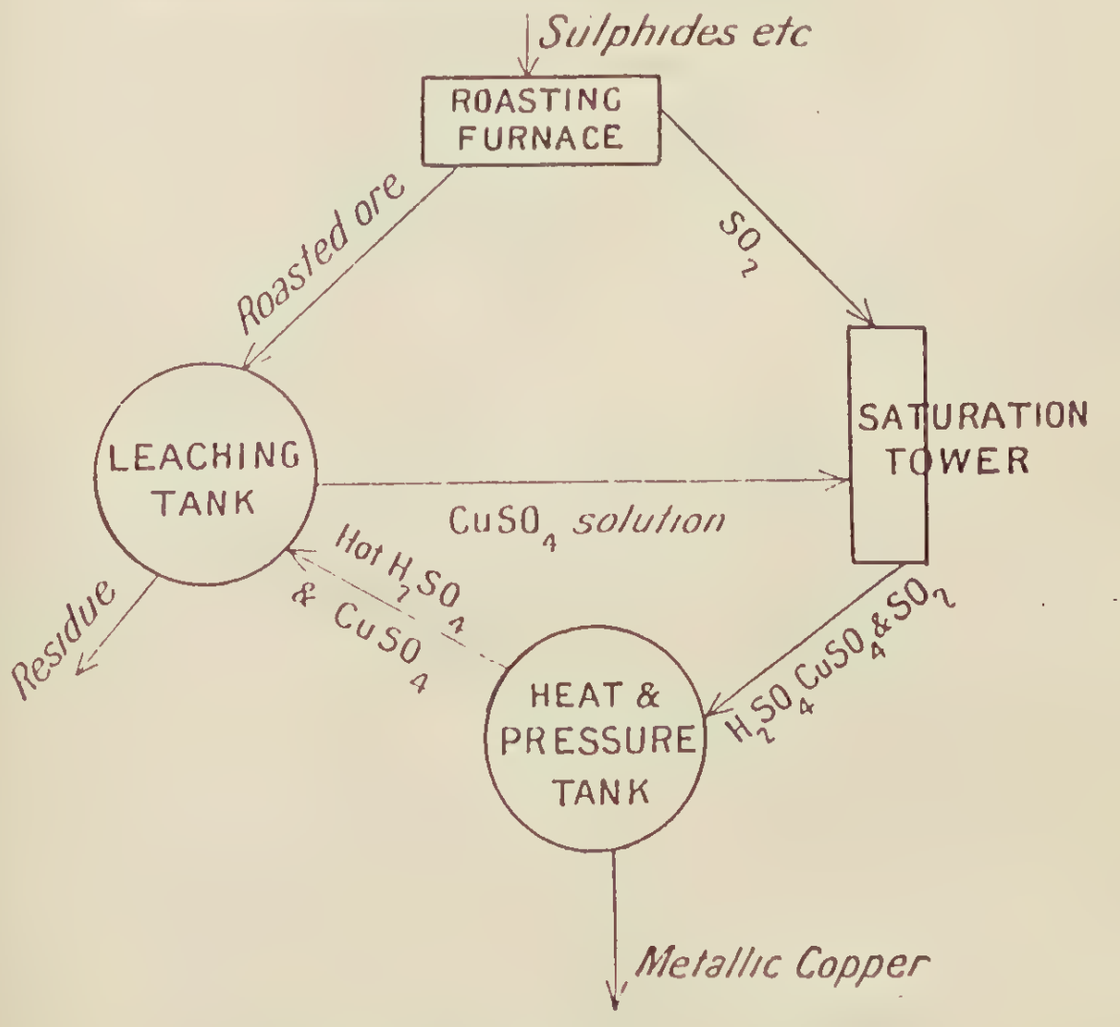


Fig. 12.—Diagram, Van Arsdale's Process.

VIII.—Electrolytic Extraction from the Ore.

There are two processes (Siemens-Halske's and Hoepfner's) available for the electrolytic extraction of copper from its ores, but nothing has yet been proved as to their working on a commercial scale. Important results have been obtained in the refining of the metal, but it is held that even in that case electrolytic methods should only be considered when precious metals are at the same time saved, and a high price is obtained for the refined copper.

1.—Copper Sulphate Solution.

(Siemens-Halske Process.)

The copper sulphide is dissolved by a solution of ferric sulphate containing free sulphuric acid. The anode of carbon and the cathode of sheet copper are separated by a diaphragm previous to the solutions.

2.—Copper Chloride Solution.

(Hoepfner's Process.)

The chlorides are dissolved and held in solution by common salt or calcium chloride, and separate solutions are delivered to a series of carbon anodes and copper cathodes (on which copper is deposited), separated by diaphragms.

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MOONMERA:

(NEAR MOUNT MORGAN)

ITS MINERALS AND COPPER MINES, AND A STUDY OF ITS ROCK FORMATIONS.

WITH 2 MAPS AND 19 PLATES.

By B. DUNSTAN, F.G.S.,

ACTING GOVERNMENT GEOLOGIST.

BRISBANE:

BY AUTHORITY: GEORGE ARTHUR VAUGHAN, GOVERNMENT PRINTER, WILLIAM STREET.

1904.

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ENVIRONS OF MOONMERA ILLUSTRATING REPORT ON THE GEOLOGY OF MOONMERA

BY

B. DUNSTAN

ACTING GOVERNMENT GEOLOGIST

SCALE

Chains 0 10 20 30 40

Miles 0 ¼ ½

To Kabra & Rockhampton

Deep Creek

Four Mile Creek

749

826

GRANITIC

ROCKS

RANGE

NORTH PEAK (1300)

CAPPED MIDDLE PEAK (1350)

SOUTH PEAK (1140)

40 ac No. 5 LEASE

No. 3 LEASE 120 ac. MOONMERA COPPER MINES

10 ac.

No. 4 LEASE 20 ac

20 ac

COAL OUTCROP IN CLIFF OF SANDSTONE

Scott's Creek

MOUNT MORGAN

RESERVE FOR MINING PURPOSES

33

22

HOTEL

9 Miles

2.58

MOONMERA RAILWAY STATION.

(593)

68

401

2.61

Creek

MOUNT SCOTT

MESOZOIC

MOONMERA

INTERMEDIATE

SHALES AND TUFFS AND SANDSTONES

CAMPING RESERVE

MORGAN AND MOONMERA RAILWAY

Four Mile

Cutting A

Cutting B.

Cutting C.

Cutting D.E.

Cutting F.

Cutting G.

INTRUSIVE

PEAK CAPPED BY SANDSTONES

RAZORBACK RANGE

(990)

(970)

MOONGAN RAILWAY STATION.

From Mt Morgan

Heads of Daisy Creek

MOONMERA: ITS MINERALS AND COPPER MINES, AND A STUDY OF ITS ROCK FORMATIONS.

INTRODUCTION.

A FEW years ago a great deal of interest was taken in a discovery of copper-bearing rocks in the country immediately to the west of Moonmera, a station on the Mount Morgan-Rockhampton Railway, and since then prospecting developments have been in progress to determine their extent, character, and richness. This work has been carried on continuously and methodically, and, as well as outcrops of ore on the surface being exposed, other masses have been discovered whose existence was not previously suspected.

It was with the view of examining these copper deposits and their associated rocks, and also the Coal Measures overlying them on the higher country in the neighbourhood, that the recent geological survey was undertaken.

Moonmera is situated about four miles north from Mount Morgan, and about nine miles south from Kabra, the station from which the railway line branches off to Moonmera and Mount Morgan. Along the railway Moonmera is 20 miles from Rockhampton, but in a direct line, in a south-south-west direction, the distance is about 15 miles.

The country to the west and south-west of Moonmera is mountainous, and is a portion of the range which, to the north, begins near the Fitzroy River at Yaamba, extends southerly to Westwood, then irregularly to Mount Victoria, Mount Morgan, Moonmera, Moongan (where it is called the Razorback Range), and Mount Usher, and again southerly to the mountains at the head of Raglan Creek and Calliope River to the west of Gladstone.

The watercourses which rise at the Razorback Range take three principal directions. Four-Mile Creek, with other small rivulets to the east of Moonmera Range—a northerly spur of the Razorback Range at Moonmera—trends north-easterly and joins the Fitzroy River near Rockhampton, while Daisy Creek with its branches trends southerly and joins the Dee River to the east of Mount Morgan. The watercourses, westerly from Moonmera Range and north of the Razorback, run northerly and north-westerly to join different branches of Neerkol Creek, which, like the creeks on the east side of Moonmera Range, finds its way to the Fitzroy River in the vicinity of Rockhampton.

The topographical features around Moonmera are of a pronounced character, Moonmera Station being about 600 feet above sea-level, while Middle Peak, to the north-west on Moonmera Range, is 1,300 feet above sea-level, between the two places there being a rise of 700 feet in a distance of about a mile. South from Moonmera the rack-section of the railway to Mount Morgan rises a little less than 300 feet in about a mile, and in the gorges at the head of the Four-Mile Creek some of the surrounding ridges rise up to 500 feet in height in a distance less than half a mile.

The Moonmera Range is capped by rocks having a westerly inclination, and this, with other features, has produced rather steeply-inclined slopes on the western side, while the almost vertical joints in the same rocks have been the principal cause in the formation of the cliffs and the very steep slopes on the eastern side.

GEOLOGICAL FEATURES.

The rock formations of the country around Moonmera have not been examined in detail, but their general features have been observed, and a brief description will assist in comprehending the character of those in the immediate vicinity of Moonmera.

Granite and syenite occur in a large number of places between Moonmera and Table Mountain, in the direction of Kabra, and the formations here are composed exclusively of these rocks. Close to Mount Morgan a large area of the same rocks are exposed, and are probably connected with those at Moonmera beneath the younger rocks of the Razorback Range.

Another series of rocks, varying in age, but closely associated with one another, and presenting many interesting features in their mode of occurrence, are the diorites, felsites, and younger granites of the Razorback. When these rocks were being formed, those which contain the deposit of copper were probably brought into existence, although the evidence obtained from their examination tends to show that the copper-bearing minerals themselves were formed at a much later period.

At Moonmera there is a marked distinction between the granite, syenite, diorite, and felsite formations, as a whole, and the formations resting on them, the latter being stratified deposits of shales, sandstones, and tuffs of Mesozoic Age. A conspicuous geological feature to the west of Mount Morgan is the Marine strata belonging to the Permo-Carboniferous formation, and whilst there are no means of telling whether these old marine beds once existed around Moonmera, there is no doubt that a slow elevation of the Moonmera Range has taken place in past times. Prior to this elevation the beds might have extended much further east than where they are now found, and then to have been worn away before the more recent deposits now resting on the top of Moonmera Range came into existence.

The beds capping Moonmera Range are Lower Mesozoic Coal Measures, and are the edge, or portions of the edge, of the basin containing the Stanwell Beds, more fully developed to the north-west of Moonmera.

There are no well-defined formations in the district later than the Coal Measures, although "Desert Sandstone" was supposed to occur on some of the ranges; but at Moonmera the discovery was made of fossils which indicates the beds to be of the same age as the Stanwell Coal Measures.

During recent times no accumulation of rock-forming material in the neighbourhood of Moonmera has taken place, the work of nature consisting in breaking down the Coal Measures and older rocks, and carrying the *débris* away to form deposits elsewhere.

Granitic Rocks.

The main mass of granitic rocks is exposed to the north of Moonmera, while the smaller outcrops, which are of more recent age, occur at a higher altitude near the ranges to the south. In the railway cuttings, close to Moonmera, the granites and syenites are too much weathered for definite determination, but about a mile north-west from the station undecomposed granite is exposed on the spurs of Moonmera Range, and also in some of the shafts and tunnels in the copper mines.

The older granite is usually found to be medium-grained, but in some localities, more particularly near the head of Deep Creek at the base of Moonmera Range, it is of a coarse texture. The prevailing mica is biotite in the unweathered rock, but where exposed and decomposed muscovite predominates.

The granites of younger age are splendidly shown to the south of the station in the railway cuttings, where they penetrate masses of syenite and felsites, and dykes of diorite. They may be divided into two series by their mode of occurrence, the later formed being conspicuous by their disturbance of the earlier series.

Sketches of portions of the railway sections are shown on a number of plates accompanying this report. Plate 8 illustrates a section on the railway line marked "Cutting A" (*See* Map 1), where a vein of granite and aplite dislocates diorite and felsite masses. Plate 9 shows, on a larger scale, a portion of the same section where the granite is surrounded by a felsite, and also shows the selvage of felsite silicified where the contact takes place between this rock and the more recent granite. The aplite is not confined to any particular part of the mass although it predominates in the narrow portion of the vein.

Plate 10 (*a*), taken from "Cutting B," shows a small vein of (*c*) aplite a few inches thick in its widest part, filling the fault and dislocating a dyke of diorite. The vein tapers away at either end within a distance of a few feet. Plate 11 represents a section in "Cutting B," where a (*b*) granite older than that shown on Plates 8 and 9 penetrates diorite, and is, itself, disturbed by a more recent (*c*) aplite vein.

Plate 12, a section taken from railway cutting (C), illustrates a system of veins of one granite traversing a mass of another, the veins probably being the equivalent of the large mass of granite shown on Plate 11, while the massive rock would be the equivalent of the oldest *(a)* granite. The section is a very interesting one, and, with others in the same locality, would bear considerably more attention from a petrological point of view than can at present be bestowed on them.

On Plate 10 *(b)*, a section from "Cutting B" represents *(a)* syenite as the main rock mass, with *(b)* granite traversing it as veins a few inches thick. With the granite occurs a pegmatite, having vermiculite conspicuous as the mica constitutent. This mineral is found in all the granite and pegmatite veins.

Plate 13 (*a*) represents a section from a small cutting between "E" and "F," and shows a vein of coarse (*b*) granite in a partly kaolinized syenite. The syenite contains small nodular secretions of a fine-grained rock of apparently the same constituents as itself, but containing a greater percentage of the more basic minerals.

Plate 13 (*b*), taken from "Cutting F," shows two veins of (*b*) and (*c*) granite—marked Gr. 2 and Gr. 3 respectively—in a dyke of diorite. The diorite has been dislocated by the first (*b*) granite, and these together—the granite and the diorite—have been disturbed by the (*c*) granite along the line of fault. The (*b*) granite is a biotite granite, while the other (*c*) is a coarse vermiculite granite. (*See* description of Plate 13 *b*.)

Plate 14 illustrates a part of the "Cutting F." The (*c*) vermiculite granite here forms irregular veins in the diorite, and also traverses masses of felsite, apparently enveloped by the diorite. Plate 15 (*b*), from "Cutting G," shows a full-size sketch of a vein of (*b*) or (*c*) granite in a dyke of diorite. The vertical portion is a biotite granite, while the rock in the branch vein graduates into an aplite near the walls, with a vermiculite pegmatite in the centre.

Plate 16, "Cutting G," represents a rather complicated structure, the (*b*) or (*c*) granite being the youngest rock in the section. This granite is of later formation than the friction breccia shown in the section, a feature of some importance in view of a large copper-bearing breccia deposit of similar appearance being associated with felsites, quartz felsites, and the older granite in the Moonmera Copper Mines.

Plate 17 (*b*), from "Cutting G," shows a (*b*) granite vertically penetrating the diorite, both of these rocks being subsequently disturbed by veins consisting of (*c*) pegmatite and (*c*) aplite. Both the (*b*) and (*c*) series contain vermiculite. Plate 17 (*b*), from "Cutting G," shows a (*c*) aplite vein crossing diorite and felsite. The vein is wide in the diorite, and tapers away in the felsite without having even a joint as a continuation of the vein.

Plate 18, representing a section in "Cutting G," shows (*c*) aplite in an irregular vein, but, being of later formation than the diorite, the fault shown at the bottom of the sketch must have been formed *prior*

to the infilling of the fissure, and from which it may be concluded that an open fissure existed in the diorite, and subsequently was filled to form a vein of aplite.

At the Moonmera Copper Mines the granite occurs in numerous localities. The section on Plate 1, across the Moonmera Range, along the line A, B, C, D, on Map 2, shows a granite at the base of the Coal Measure conglomerates in the watercourse trending westerly from the Range. Plate 3 shows a section across the granite and felsite at No. 4 Tunnel; Plate 4, a section across the granite and other rocks at No. 7 Tunnel; and Plate 5, a section at No. 2 Shaft, where granitic and felsitic rocks occur in a breccia formation containing copper. The aplite is generally found to occur in both the granular and micro-pegmatite form, some of the latter in microscopic sections showing a beautifully-marked graphic structure.

Felsites.

The origin of the numerous felsitic masses exposed on the sides of the mountains at Moonmera is rather obscure, and no data have been obtained showing, beyond doubt, what their relations are to the granite with which they come in contact. Apparently some of the felsite masses are immense inclusions in the granite, as undoubtedly others of them are in the diorite. None of the railway sections show the two rocks in contact, and the surface outcrops observed in other places have not resulted in any satisfactory conclusion being arrived at.

To the west and south-west of Moonmera Station the felsite inclusions form prominences on the ridges, and are easily recognised from the decomposed granite and syenite in which they occur. In shape they are usually lenticular, and frequently extend to over 100 feet in length, although the inclusions in the diorite are often very small. (*See* Plate 14.)

In both the diorite and the granite the inclusions have the same "orientation," being persistently northerly, but with an inclination from the horizontal varying up to perhaps 45°. All their peculiarities, especially in their relations to the diorite, point to their being included in rock masses once subjected to a flowing movement.

In the railway cuttings to the south of Moonmera the relation of the felsites to the diorites is clearly defined, and numerous sections show the felsites to be older than the diorite. On Plate 8, the alternating bands of felsite and diorite do not positively prove the diorite to be of later formation than the felsite, but in the sections represented on Plates 10 (*a*), 14, and 15 (*a*) the evidence is unmistakable.

The felsites are intimately associated with the copper-bearing rocks, as shown in some of the workings of the Moonmera mines. Plates 1 and 2 represent what appears to be a "horse" of felsite included in a breccia, although this might be connected with the large

mass of felsitic rocks shown in another part of the same section, a plan of which is given on Map 2. Plates 3, 4, 5, and 6 also show felsite in contact with granite, but the relation of these rocks to one another has not been made clear.

A microscopic slice of the felsite from railway cutting (G) shown in section on Plate 15*a*, reveals phenocrysts of quartz with traces of biotite, some magnetite in the form of dust, and a greenish chloritic substance. Another rock slide from the felsite in cutting (B) shows blebs of quartz, biotite mica in traces, grains of magnetite, and needles of apatite disseminated throughout the section.

Diorite.

Without being able to bring any decided evidence to bear on the matter, the opinion is expressed that the older granites and syenites underlie the diorite. The ascent of the Razorback Range, *viâ* the rack-section of the railway between Moonmera and Moongan Stations, indicates that the granitic rocks are below the diorite in some of the cuttings, and it is only as veins of a younger granite that they are represented on the top of the range in the diorite and felsite. The railway cuttings show the relation of the diorites to the other rocks, and some of the sections reveal remarkable features.

On Plate 8 is represented a number of dykes penetrating the felsite. The centre one is narrow, being about two feet thick, while the one on the left of the section is very massive and irregular.

Plate 10 (*a*) represents a small dyke a few inches thick in felsite, the diorite and the felsite being subsequently disturbed by a thrust fault, the fault afterwards being filled with aplite.

Plate 14 shows the inclusion of a felsite in a mass of diorite, and Plate 15 (*a*) a diorite intrusion along an open fissure in the felsite. Evidently the faulting has taken place at right angles with the plane of section, and the upper portion (*a*) of the felsite has moved forward (at an angle to the plane of the paper) over the lower portion (*b*). These diorite intrusions have taken place along joints produced in the felsite inclusions in the larger diorite masses.

Plate 16 reveals other features. The felsites have been faulted, and the fissure which formed has been filled with brecciated fragments. Subsequently the diorite has been intruded along the same line of weakness, leaving the breccia as the footwall in part, with the felsite forming the hanging-wall.

A slice from a specimen taken from the railway cutting (G) on top of the range, under the microscope showed the rock to be fine-grained, to contain hornblende decomposed in part and stained with chloritic matter, and a plagioclase felspar much kaolinized. Another slice from the same place indicated the rock to be finer-grained, to contain idiomorphic plagioclase crystals much kaolinized, and more or less altered hornblende scattered through it.

Breccia.

The breccia formation is made up of fragments of granite, syenite, felsite, and other rocks, and is one of the principal copper-bearing deposits at the Moonmera Mines. Its greatest development is about a mile north-west of the railway station, and where exposed high upon the side of the mountains is very much altered and decomposed, and more or less calcareous, while low down in the ravines it is comparatively fresh, hard, compact, and siliceous.

It has an observed thickness or depth of about 300 feet, rests on granite in a depression evidently formed by surface denudation, and is covered by the sandstones forming the top of the ranges.

Where the sandstones further west have been weathered down and the older rocks below exposed, the breccia has not been found—granite occurring instead—from which it might be assumed, when taken in conjunction with other features bearing on the matter, that the breccia formation is deepest where it is covered by the sandstones at about Middle Peak, and that from this position it becomes shallower in all directions. Resting on the western outcrop of granite (*See* Map 2 and Plate 1) there is a massive conglomerate, which might have been derived from the deposit of breccia. It is composed of the same constituents as the breccia, and is situated at a lower altitude than the upper portion of this rock where exposed on the eastern side of the range. At the same time the breccia and conglomerate might be different portions of one deposit, the western part of which has been formed into a conglomerate by the attrition of the angular fragments in water.

Sections of the breccia are shown on Plates 1 and 2. Plate 1 illustrates the relation of the breccia to the felsites and to the sandstones with which it comes in contact, and is taken along the line A, B, C, D, on Map 2. Plate 2 is a part of the same section on a larger scale, and shows the smaller felsite portion apparently isolated from the main mass further east. From the inclination of the felsite formation at No. 8 Tunnel, where it is in contact with the breccia, and from the apparent isolation of the felsite mass further up the hill, it would appear that a "horse" of felsite has become detached from a larger mass and then enveloped in the breccia formation. (Map 2 shows a plan of this near the section line E F).

Plate 4 shows a section at the mouth of No. 7 Tunnel, where a breccia, consisting of fragments of quartzite in a matrix of felsite, is contained between granite walls, the rock apparently being intrusive. Breccia also occurs in No. 6 Tunnel, where the main formation seems to have been touched at a depth nearly 300 feet below the uppermost portion of the breccia at No. 1 Shaft.

Regarding the origin of the breccia, there is not much information available whereon to express an opinion, but if the breccia occurring in one of the railway cuttings be a guide (shown on Plate 16) then the large breccia formation has been produced by the crushing of felsites, syenites, granites, and microgranites, and by the consolidation of the fragments into a compact mass. On the other hand, there is a greater probability of its being produced as volcanic ejectamenta, as there are other localities not many miles from Moonmera, in the direction of Westwood, where apparently similar breccia formations occur as volcanic necks; a careful examination of which might reveal further information bearing on the habit and origin of the Moonmera breccia.

Cupriferous Sandstones.

The copper-bearing sandstones occur at the base of the Mesozoic Coal Measures, and for the most part are very irregular and unstratified, and distinct from the overlying formation. They have been formed as detritus from the granite, felsite, and other quartz-bearing rocks, on the inclined surfaces of which they have been deposited. These cupriferous sandstones are 30 or 40 feet in thickness in some places north of the breccia formation, but other parts of the outcrop thin out into an irregular bed only a few feet thick, with granite, felsite, or breccia below, and coal-measure sandstones and tuffs above.

The variation in the thickness of the sandstones is accounted for by the varying angles of slope of the surfaces of the rocks on which they accumulated; and where the sandstones are absent, evidently the slopes of the older rocks have been too steep for the *débris* to rest on. In some places where the dip cannot be observed, it is difficult to distinguish the formation from the Coal-Measure sandstones above, as both partake of the same general appearance where they are in contact. High up on the sides of the cliffs to the west of the breccia formation, where No. 1 Shaft has been sunk, the cupriferous sandstones are absent—the granite rocks and the Coal-Measure sandstones being in contact—but south from the shaft they are present, and in that direction continue uninterruptedly for over half a mile.

The sections on Plates 1 and 2, taken along the line A, B, C, D, and that on Plate 6, on the line E F (*see* Map 2), show the relation of the cupriferous sandstones to the rocks above and below.

Regarding the origin of the copper in the sandstones, there is hardly any doubt but that the copper has been derived from the breccia and granitic rocks, and although the present position of the deposits of copper in the latter is generally lower than the sandstones, numerous features indicate that further east the breccia and granite were much higher at one time, and that the impregnation of the sandstones on their flanks by copper, leached out from the older and higher formations, would be a simple matter.

Mesozoic Coal Measures.

Sandstones and shales of a more or less ferruginous character, fine white thin-bedded tuffs, and a number of small inferior coal seams a few inches thick, constitute the Mesozoic Coal Measures resting on the cupriferous sandstone and breccia of the Moonmera Range. The Measures extend southerly to the Razorback Range, and then continue along the top of the ridges towards the west, occurring also in patches in the country to the north-west in the direction of Stanwell.

The Coal Measures do not occur easterly from Moonmera, although there are indications to show that at one time they must have extended some distance in this direction. Their contact with the formations of breccia, granite, felsite, and sandstones on the Moonmera Range show that their surfaces are rather steeply inclined to the west, and at an angle greater than that of the measures above them which dip in the same direction. As a thickness of 300 feet of the breccia is exposed, its top portion must have been extended much further to the east, where it would come in contact with the older rocks once existing there. The relation of the sandstones, &c., to the Stanwell Coal Measures was a subject of investigation, more particularly as they have been regarded as a "Desert Sandstone" formation.

The coal seams, such as they are, were considered to be of a higher horizon than the Stanwell Coal Seams, and with them to have no connection in any way. The present examination of the country to the west of the Moonmera Range, and also of the Range itself, shows that the rocks do not in any way differ from those of the Stanwell Measures. The sandstones and shales and inferior coal are similar to those at Stanwell, and the white tuffs are identical with those at Stewart's Creek to the north of Stanwell, and with those at Wycarbah near Mount Hay.

The palæontological data recently obtained also indicate their close connection, as the fossils occurring in white tuffs at the head of the gully above No. 6 Tunnel include *Alethopteris Australis* and *Thinnfeldia indica, v. Media*, the latter also being found in several places in the Stanwell Coal Measures. Bivalves occurring in the same tuffs were submitted for examination to Mr. Etheridge, the Curator of the Australian Museum of Sydney, who states that they appear to be the remains of one of the *Unionidæ* or some allied fresh-water mollusc, the distorted condition of the specimens, however, precluding a detailed description being made of them.

The Moonmera tuffs, shales, and sandstones appear to bear the same relation as the Stewart's Creek and Wycarbah tuffs do to the strata close to Stanwell, and may be considered a higher but conformable division of the Stanwell Measures. Further details will be available for consideration when the other portions of the Moonmera series come to be examined in the immediate vicinity of Mount Morgan.

Coal seams outcrop on the side of the Range to the south of South Peak, and the following section was observed by Mr. Rands, who inspected it in 1899:—*

	Ft.	In.
Coarse sandstone (thickness unknown)		
Black carbonaceous shale	2	9
Brown argillaceous sandstone	0	11
Black shales with streaks of coal	0	7
Brown shale	0	6
Black coaly shale	0	7
Brown sandy shale	0	3
Black coaly shale	0	11
Dark brown shale	0	8
Black carbonaceous shale	1	0
Total	8	2

An examination of the exposed section showed the coal to be of a dull appearance and very dirty. Some of the samples of the inferior coal yielded over 60 per cent. of ash, but small bands of the better quality gave about 30 per cent. of ash. The coal may be considered useless, not only from its quality, but also from the absence of seams of workable size. The rugged nature of the country over which the small isolated patches of the Coal Measures extend to the west of the Moonmera Range, would also make the working of a small and inferior coal seam impracticable.

Reference has already been made to the presence of conglomerates above the granite to the west of the Moonmera Range, and to the probabilty of their being derived from the breccia formation.

To the north-east of these massive conglomerates on the eastern side of the Range, another outcrop of a similar rock occurs. Very probably the two outcrops are connected with one another below the covering sandstones and tuffs, as they dip in about the same westerly direction, and are at about the same altitude. The section on Plate 1, taken along the line A, B, C, D, on Map 2, illustrates the position of the Coal Measures with regard to the copper-bearing sandstones, the breccia formation, and the granite and conglomerate on the west side of Moonmera Range. Plate 2 represents a portion of the same section on a larger scale, and shows more clearly the relation of the Coal Measures to the rocks in the vicinity of No. 1 Shaft. Plate 6 represents a section taken along the line E F, and Fig. (*a*), on Plate 7, another somewhat similar section along the line G H, also show the relation of the Coal Measures to the rocks below.

Recent Deposits.

Deposits of later age than the Coal Measures are very small in area, and are confined to the recent alluvial deposits in the beds of the creeks heading from the Razorback or Moonmera Ranges.

* Progress Report of Geol. Surv. of Queensland. By Auth.: Bris., 1900. G.S.Q.R. No. 150.

GEOLOGICAL SKETCH MAP

To accompany Report
ON THE

GEOLOGY OF MOONMERA

BY

B.DUNSTAN F.G.S.
Acting Government Geologist

SCALE

Chains 0 4 8 12 16 20

Deep Creek
Conglomerates &c.
Granite and Felsite
Gr
Gu
SANDSTONES
NORTH PEAK (1300)
North Tunnel (1050)
SHALES AND TUFFS
M
CLIFFS
Sandstones and Tuffs
Granite
NO. 5 LEASE
85° 30
Granite
Mica
Hornblende
Felsites
No. 5 Shaft (1178)
Breccia
SHAFT
OLD SHAFT
Aplite
No. 6 Tunnel (780)
Quartz veins in Aplite
Granite
Gr
CAMP
Quartz veins with Pegmatite
COPPER-BEARING BRECCIA
No. 1 Tunnel
No. 1 Shaft (1030)
NO. 3' LEASE
Aplite
FERRUGINOUS SANDSTONES
FERRUGINOUS SANDSTONE DETRITUS ON THE SURFACE
173° 30
Gr
Granite
Conglomerates
(900)
old alluvial gold workings
MIDDLE PEAK (1350)
(1200)
Lane
(B)
No. 8 Tunnel (850)
of
(C)
(F)
Quarry (795)
No. 2 Tunnel (830)
MASSIVE CONGLOMERATES BELOW SANDSTONES
Carbonaceous Shales
SLIGHT
M
CLIFFS
E
(1250)
No. 2 Shaft (975)
Felsites (1050)
Felsites
WESTERLY
Granite
Coarse
Section
Quartz Felsites
H
Biotite Granite
Creek
No. 3 Shaft (960)
Top Tunnel (750)
SOUTH PEAK (1300)
G
No. 4 Tunnel (675)
NO. 4 LEASE
Scott's
(D)
DIP (12°)
No. 7 Tunnel (580)
Gr
(790) TRENCHES
OLD SHAFT
Copper
CLIFFS
(1050)
Granite
Small outcrop of Breccia
Felsite
5° Small seams of inferior coal (See Section) PLATE I
(1010)
(950)
Granite and Felsite dykes

REFERENCE

Cu — COPPER BEARING BRECCIAS AND SANDSTONES

M — MESOZOIC SANDSTONES SHALES AND TUFFS

Gr — GRANITE, SYENITE, FELSITE

ALTITUDES (APPROX) THUS (1050)

Gold has been found in some of the creeks, of which Four-Mile Creek and the creek to the east of Mount Scott have yielded several hundred ounces. The gold appears to have been derived from the numerous quartz leaders and veins which are known to be auriferous in the vicinity of the granite and diorite, especially about Mount Scott, where a large body of stone containing these veins is said to average a few pennyweights of gold to the ton.

Gold has been found in the gullies leading down from the gap between North Peak and Middle Peak (*see* Map 2), the source of which has not been discovered. Some of the old miners suppose the gold to come from the conglomerates at the base of the Coal Measures just above, but there are old alluvial workings in one of the gullies higher than the level of the conglomerates. The gold might have been shed from some of the Coal-Measure beds above the conglomerates, or possibly it has been derived from the older rocks, which, as previously stated, once existed further east at an altitude probably higher than the sandstones.

Small transparent red stones have been found in the creeks west of Mount Scott, and are supposed to be rubies, but none could be obtained to determine whether they were rubies or, more probably, zircons or garnets.

Geological Summary.

From the preceding remarks on the geological features of Moonmera, the following deductions are made on the sequence of the rocks of the railway cuttings and at the Moonmera mines:—

1. The oldest rocks in the district are the Felsites. They have been clearly proved to be older than the diorite, and the evidence generally shows that they are also older than the granite. They have not been observed to occur in any form other than as inclusions in younger rocks.
2. Granites and Syenites are the next series, a conspicuous feature being their disturbance by diorite intrusions.
3. The third series is the Breccia Formation, the individual rock-fragments of which are made up of felsites, granite, and syenite, with a conspicuous absence of *débris* from diorite.
4. Diorite is the next younger series, forming dykes in the granite, syenite, and felsites, and disturbing the friction-breccia deposits occupying a fissure in a felsite mass.
5. Following in order are the veins of Vermiculite Granite which have penetrated the diorite and other rocks.
6. A second series of veins of Vermiculite Granite, Pegmatite, Aplite, and Quartz, which have been formed in the older vermiculite granite and other rocks.
7. Faulting of the aplite, pegmatite, and other rocks.

8. Accumulation of material to form the MESOZOIC COAL MEASURES.

9. Formation of small bodies and veins of DOLOMITIC LIMESTONE in the decomposing diorites, and the accumulation of material to form deposits containing ALLUVIAL GOLD.

Most of these formations are illustrated in the diagrammatic section on Plate 19, and the changes they have undergone will directly bear on some stratigraphic and other features of the Mount Morgan rocks, which partake of the same general character. The felsites, granites, syenites, and diorites are all similar to those close to or on Mount Morgan, and the information obtained from their examination will be made use of when a study of the rocks of Mount Morgan is undertaken. Regarding the dynamics of the *dykes* of diorite and *veins* of granite, there is enough evidence in the sections exposed in the railway cuttings to show, conclusively, that the theory of intrusion will not account for the formation of the veins of granite in the diorite and other rocks.

As stated before, the granite is intimately connected with aplite and quartz in the same vein, the aplite gradually replacing the granite in some parts, and both changing imperceptibly into a vein of pure quartz. Without losing sight of the changes which might have taken place metasomatically, it is very evident that the granite veins have been produced under the same conditions as those of the quartz veins, and the petrological examination shows no perceptible difference in the character of the quartz where the veinstone is comprised exclusively of this mineral, or where it is associated with other minerals in the granite.

MINING DEVELOPMENTS.

EXPLOITATION WORK.

The principal mining work undertaken at Moonmera has been the exploitation of the copper-bearing deposits on the side of the Moonmera Range, although the alluvial gold deposits in the water-courses, the coal seams on the sides of the Range, the auriferous formations of Mount Scott, and the quartz veins in the diorite and granite, have each received some notice from prospectors.

The exploitation of the copper deposits began many years ago, but the results then were not considered satisfactory, and the operations were discontinued. The finding of other rich outcrops, however, resulted in attention being again directed to them, and ultimately a systematic development of the deposits took place.

Without going into the details of the time and order of developments, descriptions will be given of the formations in which copper has been found. They will be considered under the headings: (1) Deposits in the Breccia; (2) Deposits in the Granitic Rocks; and (3) Cupriferous Sandstones.

Deposits in the Breccia.

No. 5 Shaft.—This shaft is situated near the western boundary of No. 5 Mining Lease, and has been sunk to a depth of 64 feet in a breccia or sub-angular conglomerate containing fragments of felsitic and granitic rocks.

The breccia also contains blebs and patches of iron pyrites and copper pyrites, with films of molybdenite in the joints. The copper is found throughout the mass of the breccia, but the quantity of metal it contains is not more than one per cent., while most of the stone has less than this amount. Concentrates have been produced from a parcel of stone from this shaft, the yield of which is said to have given 11 grains of gold and 2½ dwts. of silver per ton, and 0.65 per cent. of copper, but there was no estimate obtainable showing the amount of stone required to produce the concentrates giving this return.

No. 1 Shaft and No. 1 Tunnel.—These workings are on No. 3 Lease, on the spur leading up to Middle Peak. The breccia formation here is of immense proportions, and must be over 300 feet in vertical measurement, this being the thickness observed between the outcrop high up at No. 1 Shaft and its lowest position in the ravines.

No. 1 Tunnel has been driven a distance of 65 feet to prospect what was thought to be a lode having a north and south trend, and to be a few feet in thickness, but the developments have indicated that the copper occurs in all directions in the breccia outside this supposed lode.

No. 1 Shaft has been sunk to a depth of 50 feet, on a very rich outcrop of carbonate and oxide ore contained in the breccia formation. Two short drives have been made at the bottom, one to the south, the other to the north, the latter showing oxide and native copper in places. Excavations have been made on the surface, between No. 1 Shaft and No. 1 Tunnel, and some very rich patches of ore containing carbonate and oxide have been exposed.

A sample was taken from 50 tons of stone on the surface, obtained from the north drive and from places in the shaft, and yielded 0.31 per cent. of copper and traces of gold and silver. This stone was thrown out without any attempt being made to separate the richer portions from the worthless stone, so that classification, if adopted, might increase the percentage considerably.

A parcel of 4½ tons of stone taken away from these workings was obtained from some rich "pockets" of ore in the breccia, and sent to a metallurgical works for treatment, and yielded four dwts. of gold and two ounces of silver per ton, and 28 per cent. of copper. A similar parcel sent to another works gave almost the same results. The occurrence of these rich patches of ore created the impression that a rich lode exists, but there is nothing to indicate that such is the case.

From No. 1 Tunnel about ten tons of ore have been separated from the other stone taken out, and a sample of this yielded 1.8 per cent. of copper and traces of gold and silver.

No. 2 Shaft.—This is about ten chains south of No. 1 Shaft, and has been sunk on an outcrop of decomposed copper-bearing rocks, separated from the main body by a mass of felsite. (*See* Plates 5 and 6.)

The shaft has been sunk 50 feet below the floor of the open-cut, and from this a drive communicates with a winze, sunk from the open-cut down to the end of No. 2 Tunnel. The rocks on the surface show carbonate of copper in a number of places, and from various parts here, and from the shafts and drives, a maximum return of 3.8 per cent. of copper has been obtained; the general average, however, being less than 1½ per cent. of copper.

Experiments have been tried in concentrating the ore, and some of the concentrates have yielded nine dwts. of gold and traces of silver to the ton, and 20 per cent. of copper, but an estimate of the quantity of stone required to produce a concentrate of this richness has not been obtainable.

It has been considered that the copper contents of the ore in the winze is about 1.8 per cent., the ore in No. 2 Shaft probably 1.7 per cent., in the cross-cut 1.7 per cent., and in the tunnel 3.25 per cent.; but samples taken from the same workings show on an average only traces of copper, although small bodies of ore occur which yield up to three per cent .of copper. Fifty tons of ore at grass is said to have yielded three per cent. of copper, and that stone picked from this returned 17 per cent. of copper.

In the open-cut a sample was taken from across 18 feet of stone showing carbonates of copper, and this yielded 1.48 per cent. of copper; and a sample taken from a heap at No. 2 Shaft yielded 1.67 per cent. of copper.

Deposits in the Granitic Rocks.

No. 6 Tunnel.—The position of this tunnel is close to the south-west corner of No. 5 Lease, and between the workings of No. 5 Shaft and No. 1 Tunnel. It is situated low down in a gully leading from the gap between Middle Peak and North Peak, and was driven for the purpose of reaching the breccia formation. The direction taken is S. 10° E., and the distance driven 32 feet, but the work for the present is suspended.

The rock is a microgranite and represents, *in situ*, the same rock found with others as fragments in the breccia at No. 1 Shaft. Copper occurs as blebs of yellow sulphide, the percentage of copper being less than one per cent.

No. 8 Tunnel.—This is situated in about the centre of No. 3 Lease, and about 15 chains from No. 6 Tunnel. The formations it penetrates are felsite and granite, with a breccia at the end of the drive. The breccia is very compact and contains fragments of felsite, quartz felsite, and microgranite. Very little copper is present, and this is mostly associated with the fragments of quartz felsite.

On Plate 2 is represented a section along No. 8 Tunnel, and illustrates the position of the end of the tunnel with regard to the breccia which the tunnel was driven to strike, and an outcrop of which occurs on the surface to the north-west above the tunnel. Considered generally, the copper occurring in the tunnel is very small in amount, and there are very few tons of stone in sight which would yield over one per cent. of copper.

No. 2 Tunnel.—No. 2 Tunnel is to the east of No. 2 Shaft, and was driven 294 feet westerly, to prospect the breccia formation below the bottom of No. 2 Shaft. The rocks the tunnel is driven through are felsite and quartz felsite (with mica present as a rare constitutent), and a microgranite, and although the breccia of No. 2 Shaft must be very close to the tunnel it has not yet been discovered. Blebs of yellow sulphide of copper (copper pyrites) are seen in the rocks in the tunnel close to what may be considered an eastern boundary or limit of the copper-bearing formation, and on the surface above the tunnel at this eastern boundary copper shows freely on the surfaces of the brecciated rocks. (*See* Plates 5 and 6.)

The Quarry.—This excavation is about four chains easterly from No. 8 Tunnel, and is on the sides and botton of the channel of a water-course. The rocks are felsite and quartz felsite, with mica occasionally present. Portions of the rocks are somewhat brecciated, being made up of large angular blocks of felsite.

The copper occurs in the felsitic rocks very irregularly and very much scattered. Tons of the rock have been quarried (roughly about 200 tons), and from this about ten tons have been picked out, a sample of which, made up of portions of each heap of ore at the different faces in the quarry, yielded on assay 0.69 per cent. of copper and traces of gold and silver.

No. 4 Tunnel.—This tunnel is on the boundary line between No. 3 and No. 4 Leases, and to the south-east of No. 8 Tunnel. Its bearing is north-west, and the length about 140 feet. The open-cut at the entrance penetrated a mass of copper-bearing stone, but the tunnel passed through into a biotite granite, and continued in this rock to the face, the object in view being to cut a supposed extension of the copper-bearing stone found in the short tunnel above No. 4.

The ore at the mouth is contained in a felsite, a quartz felsite, and a much decomposed (?) dolerite, with veins of quartz and iron-stone. A sample for assay was stripped from the side of the open-cut and tunnel, where the ore is exposed, and yielded 2.5 per cent of copper and traces of gold and silver. The formation appears to be about five feet thick, but as the tunnel has been driven in the wrong direction, its extent has not been ascertained.

Close to the end of the tunnel a (?) dolerite dyke was penetrated, and in the granite on the other side there are veins of copper pyrites half an inch thick, but of no importance.

The top tunnel is 20 feet in length, and shows some very good carbonate, oxide, and sulphide ore, contained in decomposed aplite and quartz felsite. A sample was taken from all exposed places, and an assay yielded 3.89 per cent. of copper and traces of gold and silver.

On the roof, floor, and sides of the tunnel the ore is to be seen, but the work accomplished is not sufficient to determine its extent.

The illustration on Plate 3 represents a section along No. 4 Tunnel, and shows the position of the formations at the open-cut and at the top tunnel.

No. 7 Tunnel.—This tunnel is about five chains south-westerly from No. 4 Tunnel. Its bearing is S. 15° W., and its length is 201 feet.

The rocks at the entrance of the tunnel are somewhat disturbed. A breccia made up of quartzite fragments in a matrix of felsite occurs in granite, and in the granite there are irregular veins and patches of quartz, ankerite (carbonate of iron, lime, &c.), and calcite. In the granite close to the breccia there are a few fine veins and threads of copper pyrites with molybdenite.

The tunnel was driven to reach a body of stone supposed to extend downwards from the outcrop of copper ore on the crown of the hill, but it has not yet been found. The rocks in the tunnel are a biotite granite, a friable felspathic rock impregnated with iron pyrites, and a quartz felsite at the face containing traces of molybdenite.

The outcrop above No. 7 Tunnel shows copper carbonates with iron oxides freely distributed in a decomposed felsite. A sample was taken from the exposed places in the trenches, from about ten tons of ore at grass, and also from what was exposed *in situ* on the surface. Portions of the stone exposed in the trenches showed no copper at all, and these were not sampled. The returns from the assay showed 3.85 per cent. of copper.

Plate 4 illustrates a section of the tunnel, and shows the position of the outcrop of copper ore on the crown of the hill.

No. 3 Shaft.—This shaft is 50 feet deep, and is situated about 15 chains north-westerly from the outcrop above No. 7 Tunnel, and is on the line of section G H represented on Plate 7. The formation in which the shaft is sunk is a pale-greenish, friable, partly decomposed felspathic rock, containing abundance of cubical iron pyrites, and is not copper-bearing. About 20 feet to the south-west of the shaft a trench has been cut on an outcrop of copper-bearing rock showing carbonates. The rock is similar to that in the shaft, only more decomposed and iron-stained. The copper also occurs on the faces of a low cliff close to the trench, but the prospecting work at the base of the cliff does not show any features indicating a continuation of copper in depth, although the few tons of stone around the trench above must average two or three per cent. of copper.

No. 3 Shaft was sunk to prospect for gold as well as copper, because of the resemblance of the stone in the outcrop to some of the auriferous stone occurring in the Mount Morgan Mine, but the results were not satisfactory. The heap of stone at the shaft, which might contain about 50 tons, was sampled over the surface, and the assay of this yielded traces of copper, gold, and silver.

A sample was taken of the surface stone at the cliffs and the trenches, and from the ore at grass, but only stone was taken in which copper was present, barren portions being excluded. This sample yielded 0.96 per cent. of copper and traces of gold and silver.

The rock in which No. 3 Shaft has been sunk, evidently extends south-easterly to the outcrop above No. 7 Tunnel, and also below to the tunnel level as shown in Plate 4.

Copper is also present in the rocks of the same belt about 50 feet to the north-west of the outcrop above No. 7 Tunnel. A small excavation has been made, and the ore exposed shows a resemblance to that above No. 7 Tunnel.

Other Localities.—An old abandoned shaft situated easterly from No. 5 Shaft was examined. It is 15 feet deep, and is sunk on a decomposed felsite traversed by a vein of aplite, both of which were found to be impregnated with copper carbonates and copper pyrites. The appearance of the vein suggests that more should be known as to its extent. Copper carbonates also occur on the surface of the ridge further to the east.

Another old shaft, 25 feet deep, situated south-east of No. 7 Tunnel, and outside No. 4 Lease, was examined. The formation is a decomposed felsite and granite, with fine veins of carbonate and oxide of copper. About one ton of stone is lying about on the surface containing, perhaps, five per cent. of copper, but the bulk of the stone taken out does not show copper at all.

Cupriferous Sandstones.

North Tunnel.—This tunnel is situated on the central one of the three leases north of those belonging to the Moonmera Copper Company, and is about ten chains east of North Peak.

The formation is sandstone, more or less ferruginous and clayey in parts, with interbedded gritty ferruginous tuffs. The sandstones are impregnated with blue and green carbonates of copper and the red oxide (cuprite), while the red tuffs in patches are spotted with the carbonates.

The tunnel is driven westerly along the dip of the copper-bearing sandstones, which are exposed for some distance along its sides and at the face. Samples were taken from all the exposed places in the tunnel showing copper, also from one ton of picked ore at the entrance, and from about 20 tons of ore in the paddock near the entrance. The result of this, on assay, gave one per cent. of copper, and traces of gold and silver.

Cliffs near South Peak.—On the edge of the cliffs to the east of South Peak, which is the most southerly of the three prominent peaks on the Moonmera Range, there is an exposure of the cupriferous sandstones below the regular-bedded Coal Measures. This formation extends northerly and southerly (*see* Map 2), and shows traces of copper in several places.

On an exposed cliff, about twelve chains south-east of South Peak, marked "Copper" on Map 2, the sandstones are impregnated with carbonates and red oxide of copper, some portions of which undoubtedly are very rich. Concerning these rich portions no definite opinion can be expressed, as they are simply outcrops, their richness probably being due to the leaching out of the copper from sandstone not exposed, and deposition taking place on the sides of the cliffs. The sample taken from here yielded 2.68 per cent. of copper, and traces of gold and silver.

Other Outcrops.—Sandstones, containing rich patches of carbonate of copper, occur in numerous other places along the cliffs, and some of these patches of ore undoubtedly have been formed by the leaching out of the copper to form efflorescences below the overlying rock ledges.

Summary of Mining Work.

In reviewing all the work which has been in progress at the Moonmera Copper Mines, it becomes apparent that, although some of the prospecting work has yielded satisfactory results, most of the work has been unsuccessful in establishing the existence of well-defined bodies of copper ore.

A few of the outcrops show signs of being permanent, but others are irregular and unreliable in their occurrence. That copper ore exists in enormous quantities is unquestionable, as outcrops of ore can be observed in a vast number of places high up on the mountain slopes in the sandstones and breccia, and lower down in the belt of granitic and felsitic rocks.

Of the most promising localities where developments have exposed the formations carrying copper, or are in positions favourable for working, No. 6 Tunnel should first be mentioned. The further extension of this tunnel may not be in accordance with the scheme of development laid down; but, after all, it is more important to first prospect the ore bodies and find out their value, than to put in levels for working the mine and then prospect for ore-bodies afterwards.

Quite possibly No. 6 Tunnel would reach the breccia if extended a short distance, and the finding of this formation so far below No. 1 Shaft would reveal what its character and quality are in depth.

No. 1 Shaft and No. 1 Tunnel are favourably situated, and should it be found advisable to further prospect the breccia, these workings will be found to be in a good position for development.

The developments at No. 2 Shaft in the breccia formation show very decidedly what the stone is like in this neighbourhood, but as No. 2 Tunnel has failed to reach the breccia, an alteration in the direction of the tunnel by driving more to the north would probably be more successful, as the inclination of the breccia formation is north-westerly.

No. 8 Tunnel, as well as penetrating the breccia exposed above the tunnel, is also prospecting the breccia in which No. 2 Shaft is put down. Both these workings are on the same belt, the outcrop of which extends from No. 2 Shaft in a north-easterly direction to the hill in which No. 8 Tunnel is driven.

The Quarry, near No. 8 Tunnel, does not yield any definite information concerning the trend of the rocks in the neighbourhood. Although there are possibilities of its being connected with the copper outcrops at No. 4 Tunnel as has been supposed, there is very little evidence to be obtained from it on which to base an opinion, and the copper belt, if such a thing exists, might be in quite a different direction. The individual outcrops in this part of the granite area, and also in other parts, are so numerous that it would be very easy to fall into the error of supposing that a connection exists between several of them, and to assume that they were the various outcrops belonging to more or less defined lode formations.

Work should not be continued at No. 4 Tunnel, unless it is to explore the small formations passed through on the east side, but the tunnel above No. 4 Tunnel, named the "Top Tunnel" on Plate 3, should be prospected, if it were found necessary to determine the extent of the ore body there.

In No. 7 Tunnel work should not be continued until the outcrop above it on the crown of the hill has been further examined and more known about its trend.

In No. 3 Shaft the stone has been sufficiently tested to show its quality, and no encouragement can be given to do any additional work here.

Attention is directed to the outcrop of copper-bearing sandstone south-east of South Peak, where prospecting might reveal a body of ore. The stone is good in quality, and, although it might only be rich where exposed, quite possibly it extends into the hill for some distance.

Concerning the North Tunnel, the examination shows that a regular and permanent formation of sandstone of about four feet in thickness is present, and there is every indication of the copper carbonates in it continuing into the hill to the south.

Generally considered, the exploratory work indicates that the copper ore in the granitic and felsitic rocks has failed to give good results, and except where they may furnish some information regarding the occurrence of the breccia, with which they come in contact, it is questionable whether any further exploitations should be made in

them. If anything is done, the breccia is the formation in which attention should be more concentrated, but limited to those places previously referred to, while the outcrops of copper-bearing sandstones should not be neglected.

Regarding the mining work, a few words of advice may not be out of place. The practice of putting in large tunnels for development and for working out the ore bodies, before the character of the deposits is understood, is not to be commended under any conditions, and at Moonmera it is evident the deposits have not been understood, from the failure of most, if not all, of the tunnels to penetrate the ore bodies which they were put in to test. Impregnations of granite or felsite, or other such rocks, are always of an uncertain character, and very different to a well-defined lode formation or vein, and so their exploitation should be undertaken on lines altogether different to that which has been followed.

Concerning concentration, it may be stated that, as the ore is a low grade one, it would be necessary to adopt some method of reducing the proportion of gangue to mineral prior to metallurgical treatment. There are very large quantities of ore containing traces up to about two per cent. of copper, and while much of the ore cannot be hand-picked, some of it could be treated in this way, on account of the favourable condition in which the minerals occur in the gangue.

Crushing and concentrating some of the ore could be satisfactorily performed, as trials have shown, and the latest return available shows that 7½ tons, taken from No. 2 Shaft, were concentrated to 16 cwt. containing 12.5 per cent. of copper and six dwt. of gold.

LIST OF MINERALS.

Name of Mineral.	Occurrence.

Ankerite.—This iron-lime carbonate is associated with calcite and quartz crystals in decomposed granite at the mouth of No. 7 Tunnel. (*See* Plate 4.) The quartz crystals occur in vughs on which the ankerite, in a massive crystalline form, has been deposited. The calcite is a subsequent crystallisation on the ankerite and quartz. The mineral is white, but rapidly oxidises to a yellow colour on a freshly-exposed surface.

Atacamite.—An oxi-chloride of copper occurring with halite (sodium chloride) on the surface of a friable sandstone near the North Tunnel. Rare.

Azurite.—Blue carbonate of copper. Found in numerous places all over the field. At the North Tunnel it is in the form of small lenticular scales in tuffs and sandstones, and also as impregnations in the latter rocks.

Biotite.—A common mica in the older granites about Moonmera.

Calcite.—In No. 7 Tunnel, associated with quartz and ankerite.

Chalcedony.—Occurs in the felsite in the quarry near No. 7 Tunnel as an encrustation on quartz crystals. Originally the quartz crystals were embedded in copper pyrites, but the latter mineral has been removed and the chalcedony has formed on the crystal faces.

Coal.—Inferior coal occurs on the Moonmera Range, in Mesozoic rocks. (*See* Plates 6 and 7, and Map 2.)

Copper Pyrites.—The matrix of this material is usually the granitic rocks, but it occurs in many different varieties of the acid rocks, noticeably where in contact with those more basic in composition. In the lower outcrops of the breccia it is also found.

Cuprite.—This oxide of copper occurs near the surface of the copper-bearing rocks in the granites and felsites, but it is found far below the surface in the breccia. It is also present in the sandstones on the Range.

Copper Glance.—At No. 1 Shaft and No. 1 Tunnel in small bodies.

Dolomite.—Common as patches and veins in the Moonmera-Moongan railway cuttings.

Galena.—Traces found with the copper pyrites in several of the mine workings.

Gold.—In veins and reefs at Mount Scott, &c. As alluvial deposits in the watercourses east and west of Moonmera Range.

Hematite.—Occurs in the copper-bearing outcrops, and in the sandstones and tuffs on the Range.

LIST OF MINERALS—*continued.*

Name of Mineral.	Occurrence.
Halite.	Formed as an exudation in the caves in the sandstone cliffs of the Range.
Hornblende.	In the syenites and diorites in the railway cuttings.
Iron Pyrites.	Common in the Moonmera mine workings; abundant at No. 3 Shaft and No. 1 Tunnel.
Limonite.	On the outcrops of the copper-bearing rocks; also in the sandstone on the range.
Malachite.	Found in numerous places on the field. At North Tunnel impregnates the sandstones.
Melaconite.	Occasionally found as a black coating to the copper pyrites in the mine workings.
Molybdenite.	Filling the joints and occurring as flakes in some of the felsites; occasionally as small masses a few inches in diameter.
Muscovite.	In some of the newer granite veins in the railway cuttings, and in the older decomposed granite.
Native Copper.	In the breccia and sandstones in several places, particularly about No. 1 Shaft and No. 1 Tunnel.
Quartz Crystals.	At No. 7 Tunnel and in the quarry near No. 8 Tunnel.
Vermiculite.	In abundance in the veins of granite and pegmatite in the railway cuttings between Moonmera and Moongan. It is in small scales, having very much the appearance and habit of muscovite. Before the blowpipe it exfoliates remarkably; then fuses to a black glass.

ALTITUDES (Approx.)

	Feet.		Feet.
Middle Peak	1,350	No. 2 Tunnel	880
South Peak	1,300	No. 8 Tunnel	850
North Peak	1,300	Quarry	795
Gap South of Middle Peak	1,250	No. 6 Tunnel	780
No. 1 Shaft	1,050	No. 5 Shaft	778
North Tunnel	1,050	Top Tunnel (above No. 4 Tunnel)	750
No. 1 Tunnel	1,015	Trenches above No. 7 Tunnel	790
Coal Seam Outcrop	1,010	No. 7 Tunnel	680
No. 2 Shaft	975	No. 4 Tunnel	675
Moongan Railway Station	970	Moonmera Railway Station	593
No. 3 Shaft	960	Scott's Creek at Railway Line	548
¼-mile west of Middle Peak	900		

Brisbane, 2nd September, 1902.

B. DUNSTAN,
Acting Government Geologist.

By Authority: George Arthur Vaughan, Government Printer, William street, Brisbane.

PLATE 1.

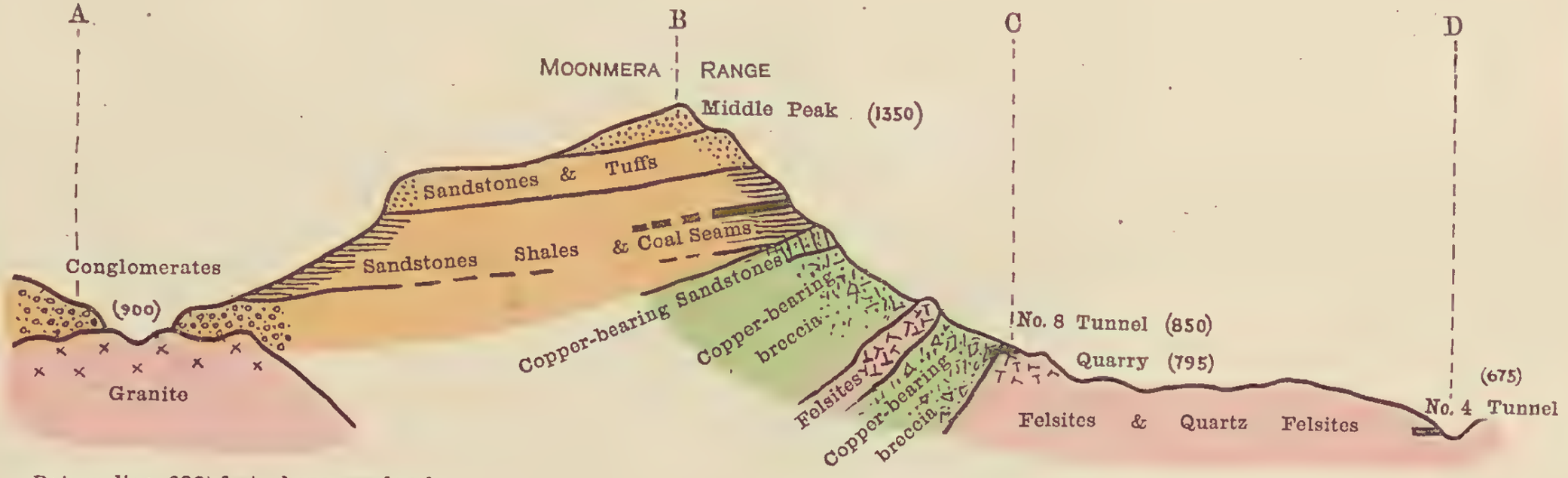
Geological Section across Moonmera Range.

The geological section across Moonmera Range along the curved line A, B, C, D, on Map 2, shows most of the formation of the district. The granite with the felsite and quartz felsites are the basement rocks, on which have been deposited the copper-bearing breccia to the east and the conglomerates to the west of the Moonmera Range, and above these are the sandstones, tuffs, and inferior coal seams of the Mesozoic Coal Measures.

The altitudes are approximate.

Geological Section across Moonmera Range

Section along line A B . C . D . on Map 2.



Horizontal Scale 0 ¼ Mile

Vertical 0 300 600 Feet

Geological Survey of Queensland

Plate 1

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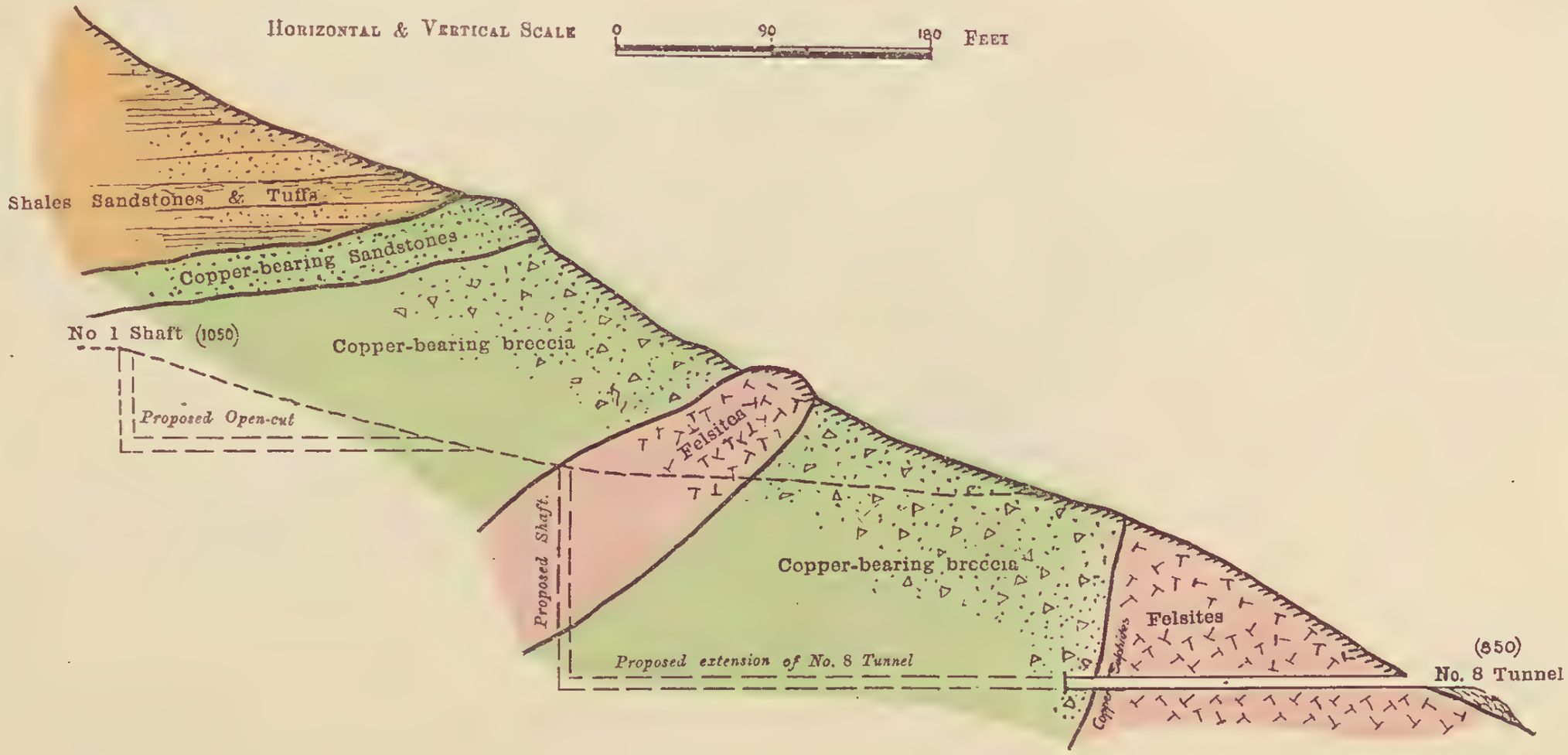
PLATE 2.

Geological Section (East of Moonmera Range) on Line B C.

The section along the line B C, on Map 2, illustrates the position of the geological formation at No. 8 Tunnel and No. 1 Shaft. At the top of the section are the Coal-Measure sandstones, shales, and tuffs, below which, at a steeper angle of dip, are the copper-bearing sandstones. The felsite "horse" seems to be enveloped by the breccia, and distinct from the mass of felsites further east in No. 8 Tunnel.

Section along line B.C. (Map 2)

(NO 8 TUNNEL & NO 1 SHAFT)



GEOLOGICAL SURVEY OF QUEENSLAND

Plate 2

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PLATE 3.

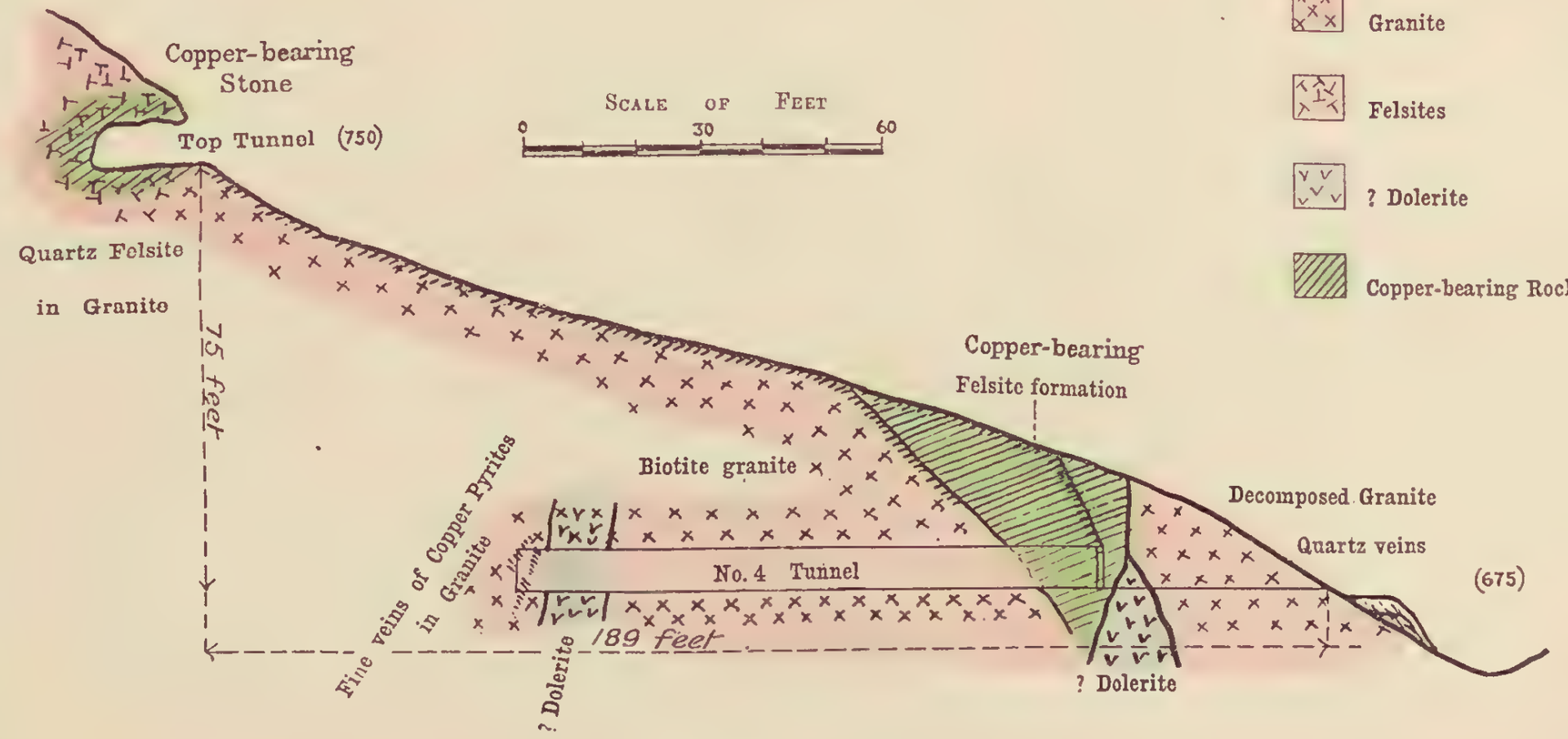
Section along No. 4 Tunnel.

The section along No. 4 Tunnel shows the copper-bearing vein in the granite and its relation to the (?) dolerite with which it comes in contact. The course of the copper-bearing vein is at an angle with the direction of the tunnel, and, in consequence, the vein has been cut and passed through obliquely. At the end of the tunnel a few half-inch veins of copper pyrites in granite was found near another (?) dolerite dyke, but of limited extent.

The Top Tunnel copper impregnates the granite and quartz-felsite, but no lode formation exists.

Further references to No. 4 Tunnel are made on page 21.

Section along No. 4 Tunnel (See Map 2)



GEOLOGICAL SURVEY OF QUEENSLAND

Plate 3

VICTORIA

PLATE 4.

Section along No. 7 Tunnel.

The section along No. 7 Tunnel exposes near the entrance a dyke of felsite with included quartzite fragments, and contained between walls of granite. Quartz with ankerite occurs in the dyke, and molybdenite with copper pyrites exists as fine veins and threads in the decomposed granite close by. A friable felspathic rock penetrated in the tunnel appears to be the same rock exposed on the crown of the hill just above it. Copper occurs in the outcrop on the hill, but has not been found in the tunnel. At the end of the tunnel threads of molybdenite make their appearance in the quartz felsites. Further references to No. 7 Tunnel are made on page 22.

SECTION ALONG No. 7 TUNNEL

(See Map 2)

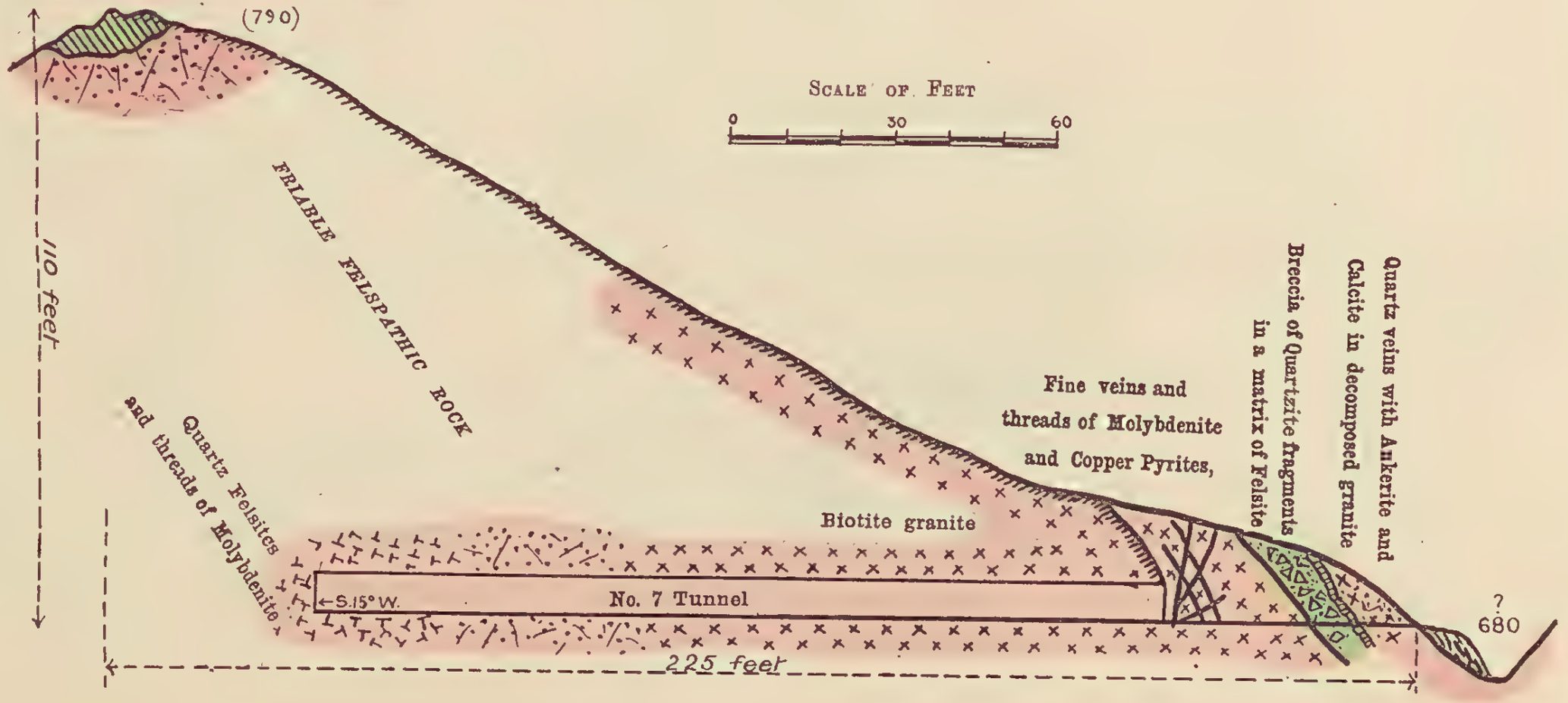


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PLATE 5.

No. 2 Tunnel and No. 2 Shaft.

The workings of No. 2 Tunnel and No. 2 Shaft are shown in plan and section. The copper-bearing formation lies between granite and felsites, and apparently has an easterly underlie. The cross-hatching represents the portion found to be copper-bearing stone, independently of the kind of rock containing the mineral. References to the copper contents of the workings are given on pages 20 and 21

WORKINGS AT No. 2 TUNNEL AND No. 2 SHAFT

Scale

HORIZONTAL & VERTICAL

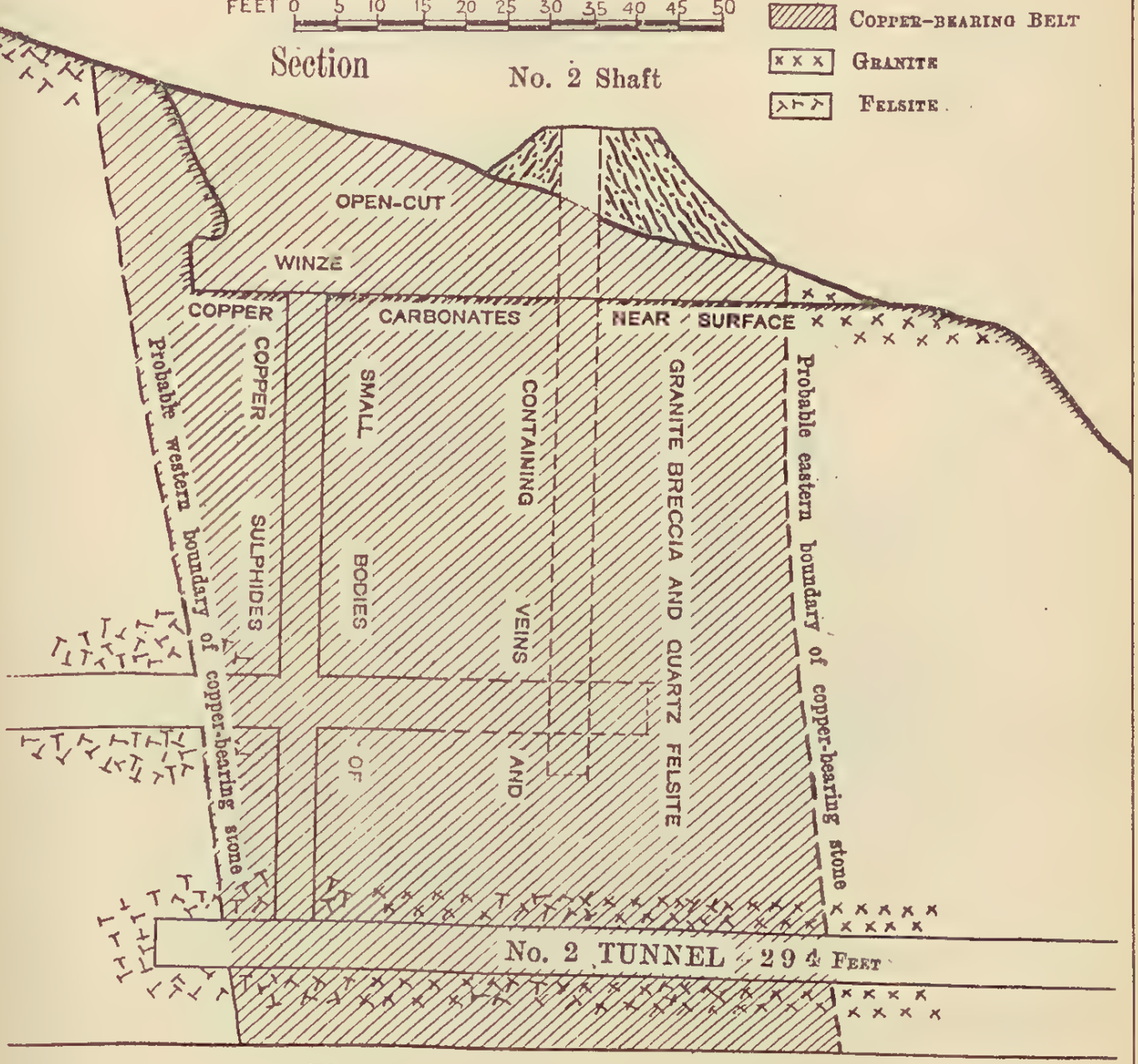
FEET 0 5 10 15 20 25 30 35 40 45 50

COPPER-BEARING BELT

GRANITE

FELSITE

Section No. 2 Shaft



Plan

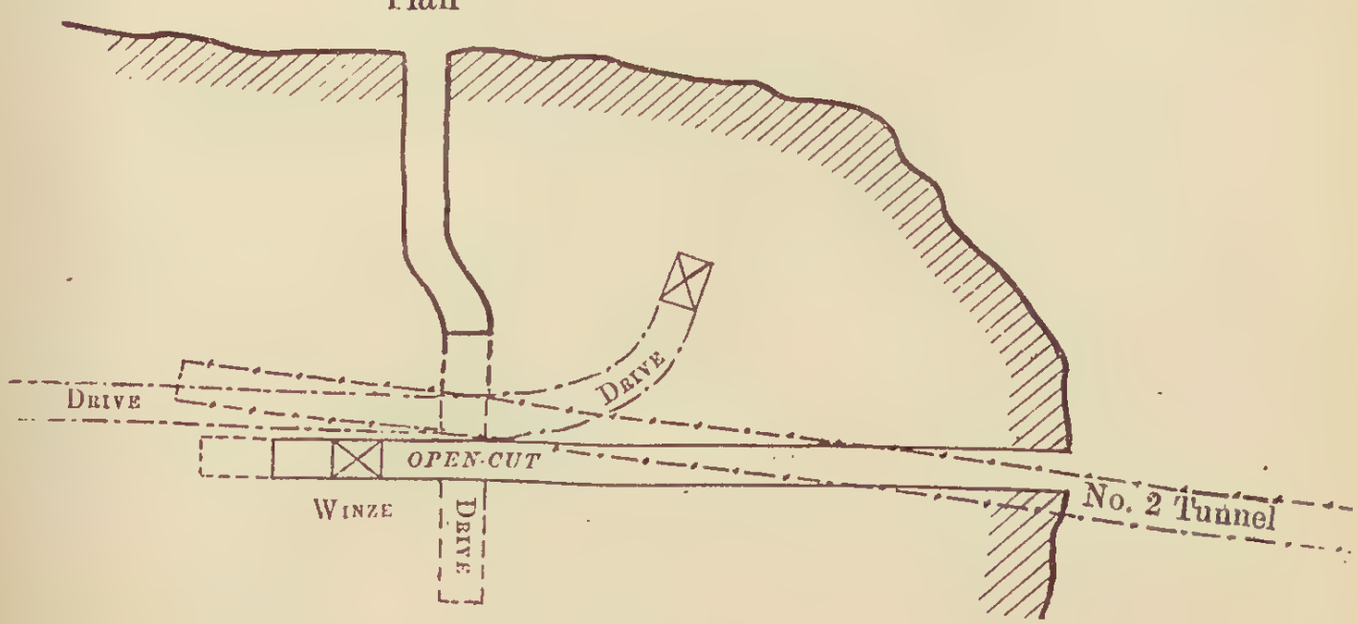


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PLATE 6.

Geological Section from Moonmera Range to Quarry.

The geological section from Moonmera Range to the quarry, along the line E F, on Map 2, illustrates the slightly-inclined Coal-Measure sandstones, shales, and tuffs, the steeply-inclined copper-bearing sandstones, and the felsite mass between the latter formation and the copper-bearing breccia further east.

GEOLOGICAL SECTION FROM MOONMERA RANGE TO QUARRY

SECTION ALONG LINE E. F. (ON MAP 2.)

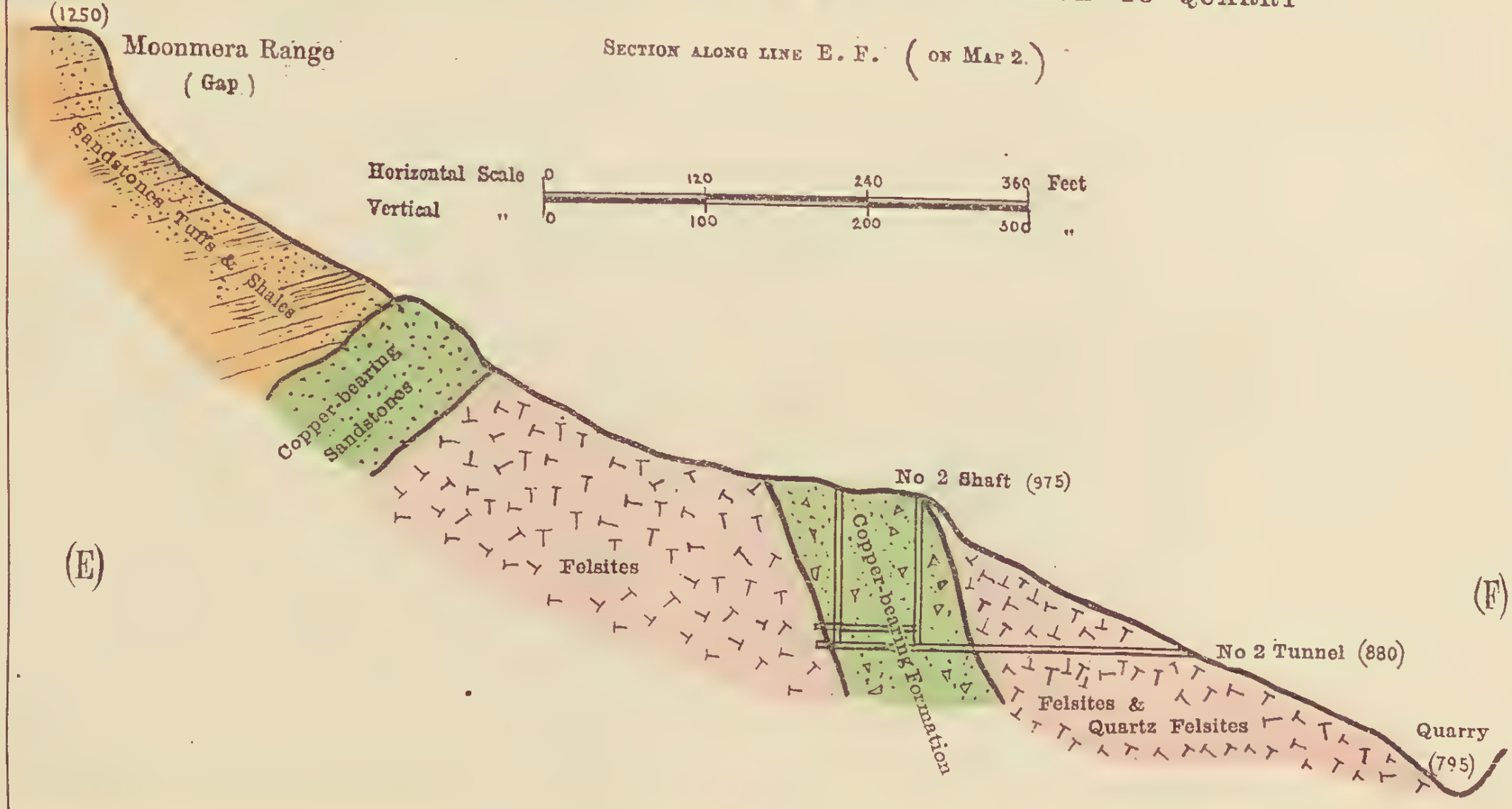

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PLATE 7.

a

Section East of Moonmera Range.

Section along the line G H, on Map 2, between South Peak and No. 3 Shaft. It shows the steep angles at which the irregular cupriferous sandstones are inclined to the west, and also the less inclined overlying Coal Measures.

A White tuffs.
B Sandstones.
C Shales with coal.
D Copper-bearing sandstones.
E Felsites.

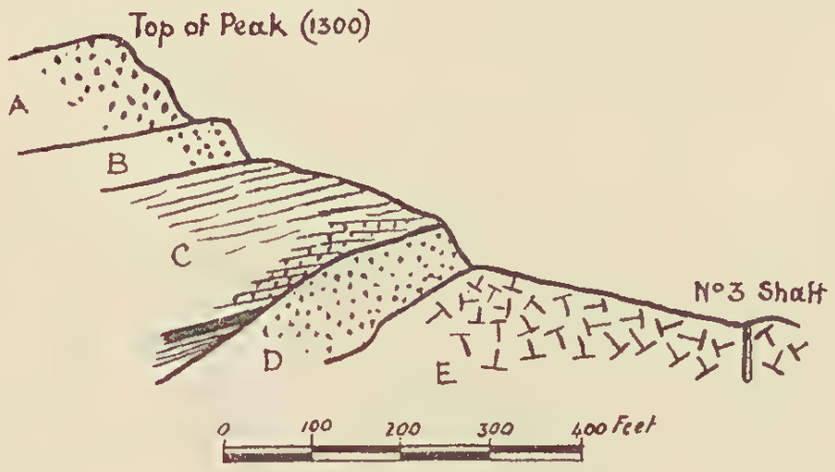
b

Breccia at No. 5 Shaft.

A section of breccia from No. 5 Shaft, showing the angular and sub-angular fragments of a bluish quartzite (*b*) in a matrix of felsite (*a*). A microscopic section showed the quartzite to be made up of fragments much altered and of varying degrees of fineness, and to contain magnetite dust.

Scale: 1 inch = 6 inches.

(a)



(b)

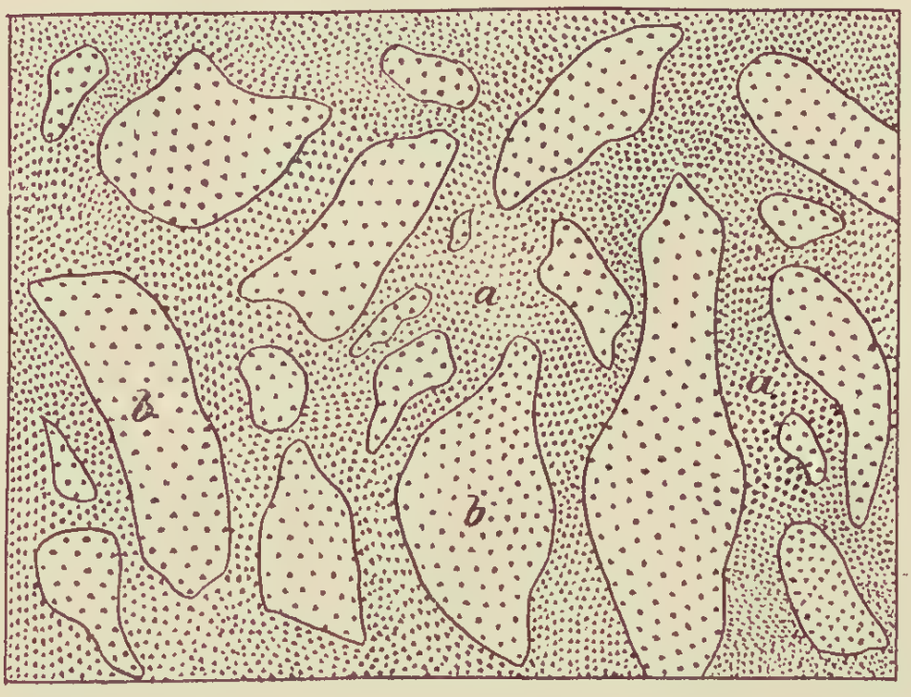


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PLATE 8.

Section from Railway Cutting (A).

In this section large and small dykes of diorite have penetrated what is probably a broken-up mass of felsite included in a larger mass of diorite. A vein of fine-grained aplite and granite has been formed in the diorite and felsite.

Mica and hornblende occasionally occur in the diorite and felsite.

The horizontal diorite masses would appear to have been previously connected with one another, but taken in conjunction with the section (A) illustrated on Plate 15, it is evident that an open fissure in the felsite was formed, subsequently faulted, and then filled with diorite.

Scale: 1 inch = 12 feet.

Fe
Di
Fe
Di
Di
Fe
Di
Di
Di
Fe
Di
Ap
Di
Di
Di
Di Diorite
Fe Felsite
Ap Aplite & Granite

VICTORIA

PLATE 9.

Section from Railway Cutting (A).

An enlarged view of the aplite and granite vein shown on Plate 8. The section illustrates the system and joints in the felsite and the silicification of the felsite where it comes in contact with the aplite and granite. The silicification, however, is not limited to where the two rocks are in contact, as it occurs along some of the joints (shown dotted) in the felsite.

The aplite is fine-grained in places, almost felsitic, but also occurs of a coarse-grained texture and graduates into a vermiculite granite.

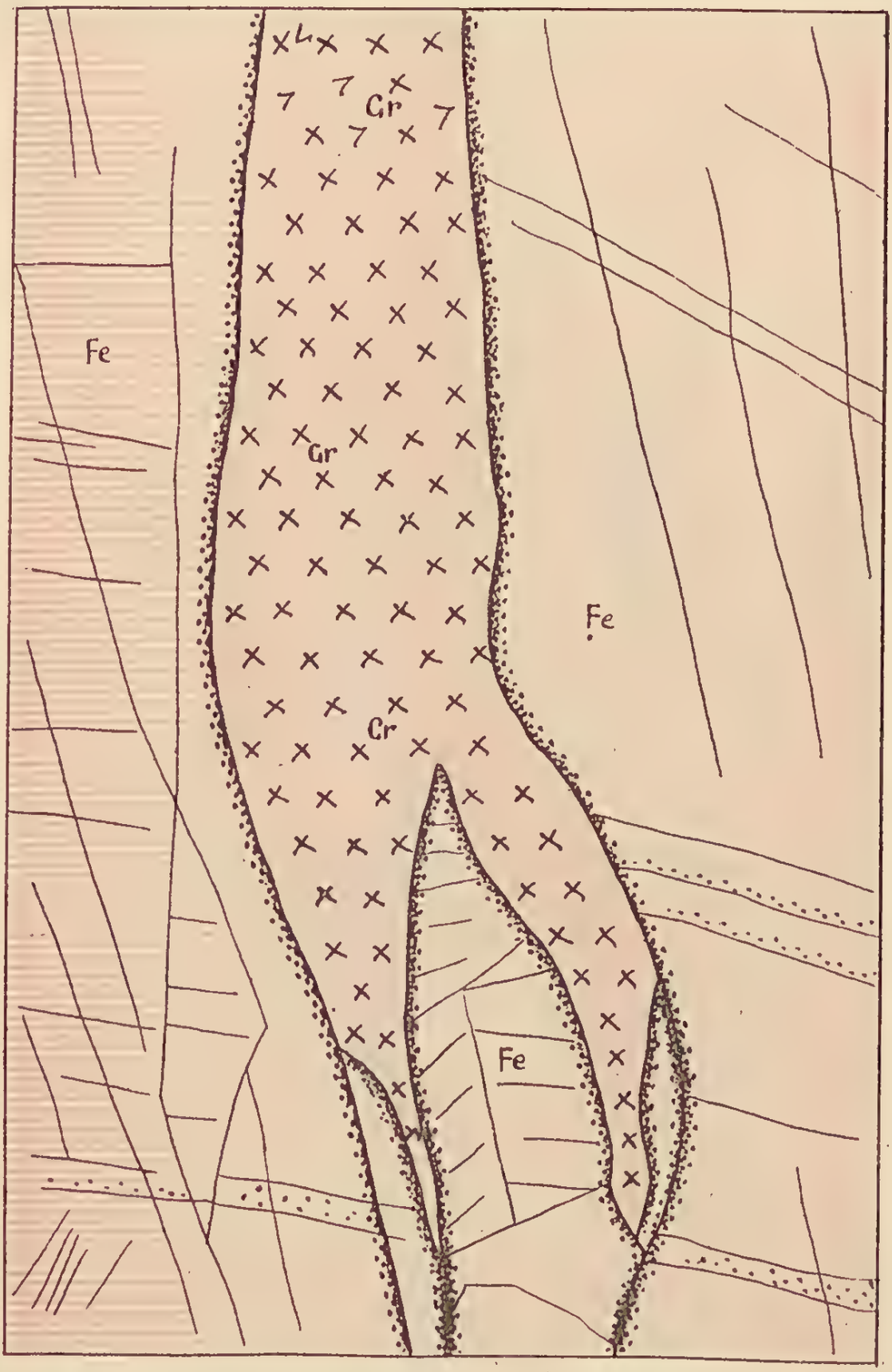
Fe
Gr
Gr
Gr
Fe
Fe
Fe Felsites
Gr Aplite & Granite

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PLATE 10.

a

Sections in Railway Cutting (B).

A felsite mass in the railway cutting (B), shown on Map 1, has been intruded by a diorite dyke. Subsequently the two rocks, as one mass, have been faulted, and in the resulting fissure an aplite has been formed, this rock graduating into a clean quartz in the smaller parts of the vein.

Scale: 1 inch = 8 inches.

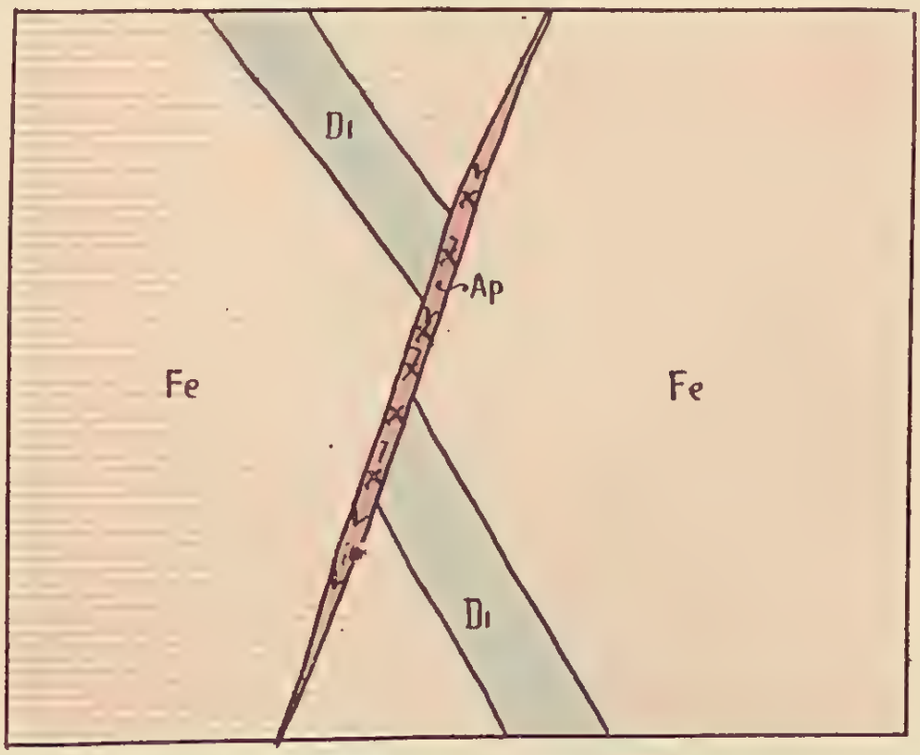
b

Aplite and pegmatite granite veins have been formed in the massive syenite, across both of which a series of small veins of aplite has more recently been formed.

Scale: 1 inch = 14 inches.

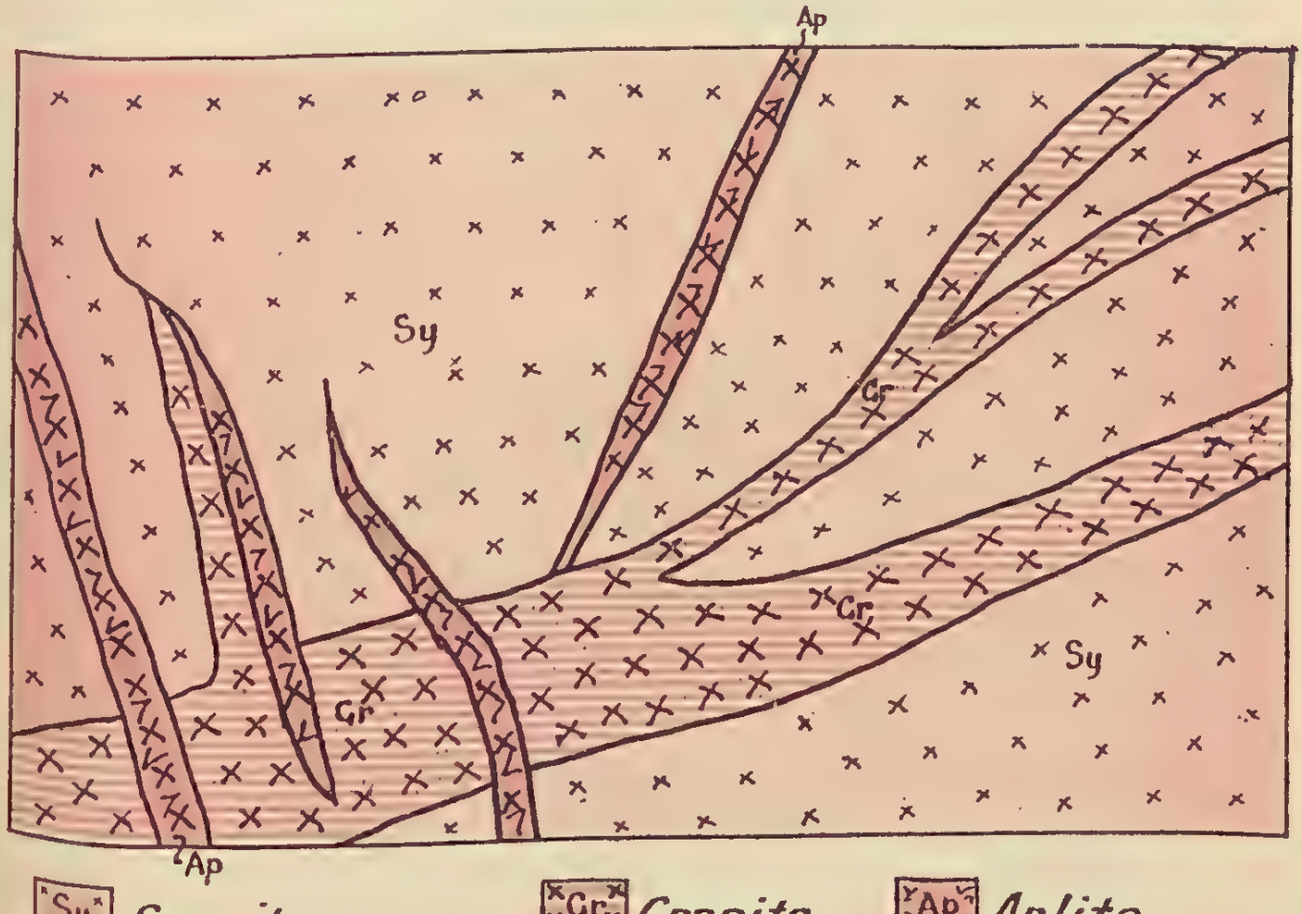
VICTORIA

(a)



Fe Felsites Di Diorite Ap Aplite

(b)



Sy Syenite Gr Granite Ap Aplite

VICTORIA.

PLATE 11.

Section in Railway Cutting (B).

In this section the diorite (Di.) has been faulted, and a mass of vermiculite granite (Gr.) has been formed in the fissure. Across the diorite and granite some veins of aplite (Ap.) and quartz have been subsequently formed.

Scale: 1 inch = 3 feet.

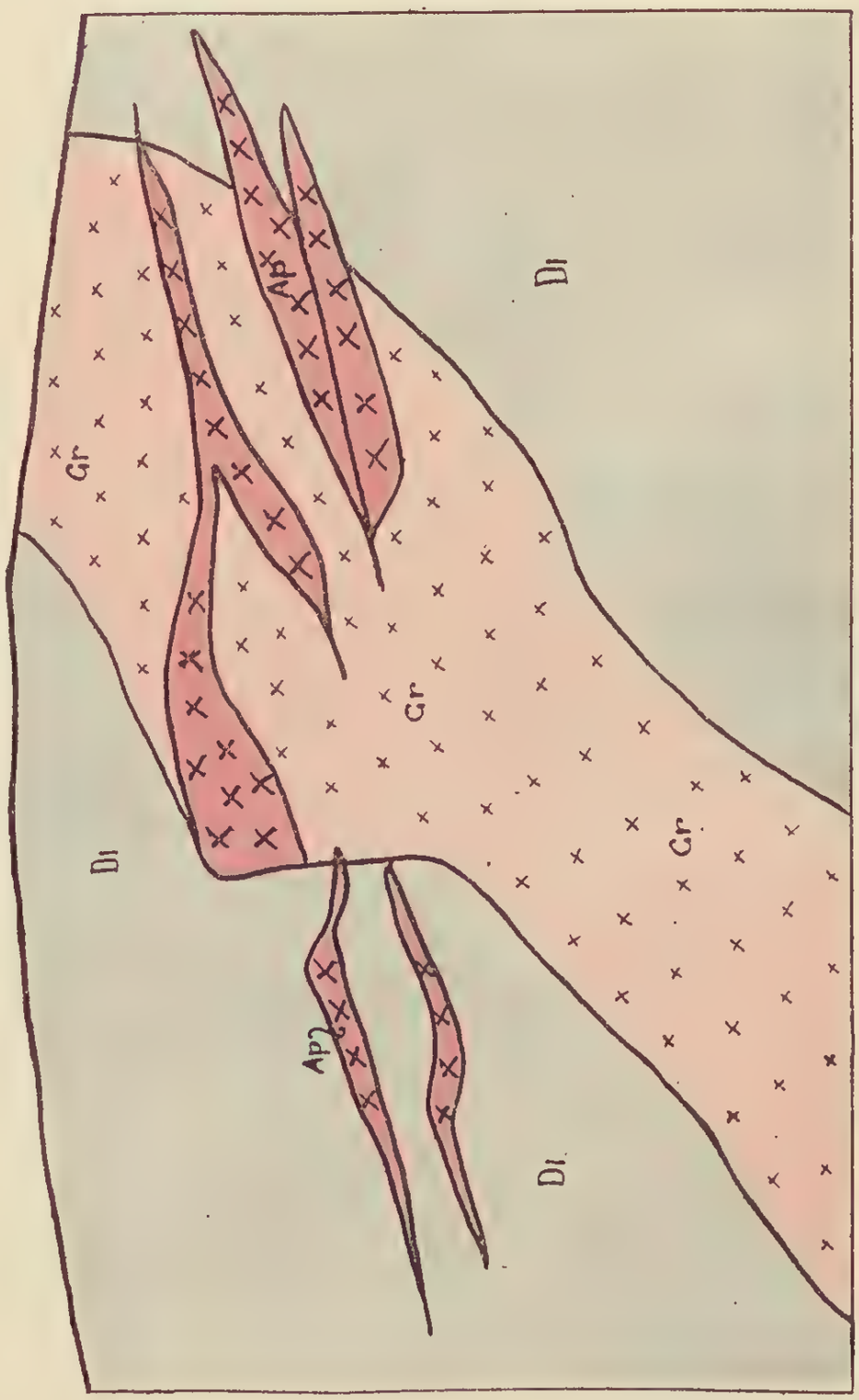

Di
Gr
Ap
Gr
Di
Ap?
Gr
Di
Di Diorite
Cr Granite
Ap Aplite

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PLATE 12.

Section in Railway Cutting (C).

In this section the massive fine-grained granite has been broken up into blocks, and faulted along the joint planes. The character of the faulting and the formation of short gashes show that the granite has not been in a rigid condition.

The veins of the vermiculite granite are probably the equivalent of the granite in the section on Plate 11, while the massive rock would be the equivalent of the oldest (*a*) granite. (*See* Plate 19.) The vermiculite granite is coarse-grained. Under the microscope the felspar is seen to be decomposed, and while some of the mica, evidently undecomposed biotite, is strongly pleochroic and coloured green, other portions are not pleochroic and are coloured deep brown.

Scale: 1 inch = 6 feet.

Gr
Vg
Vg
Gr
Recent Drift
Granite
Vermiculite Granite

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PLATE 13.

a

Section between Railway Cuttings (E) and (F).

The section indicates that, without any apparent faulting, an opening has been made in the syenite in which a 6-inch vein of coarse pegmatite granite has formed. The branch fissure appears to have originated simply by the widening of a crack, the irregularities in the top and bottom walls showing they were once in contact.

Scale: 1 inch = 14 inches.

b

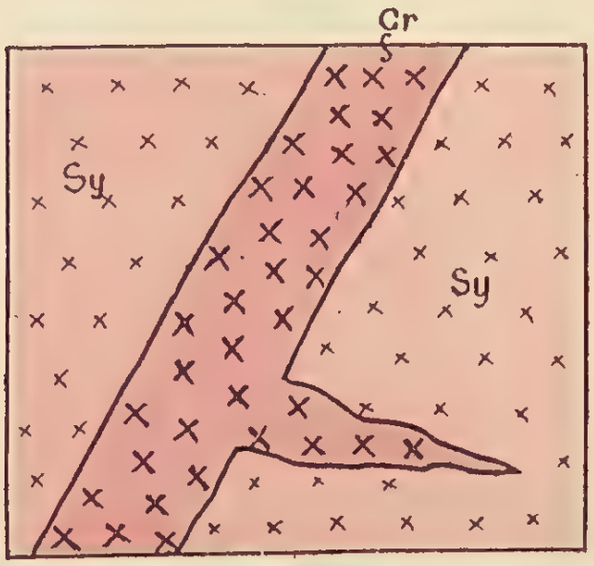
Section in Railway Cutting (F).

A diorite has been dislocated, and in the fissures which have been opened veins of fine-grained biotite (*b*) granite—marked Gr. 2—have been formed. Afterwards the diorite and the veins of fine-grained granite have been disturbed and faulted, and the opening made has been filled with a vein of coarse-grained (*c*) vermiculite granite (marked Gr. 3).

To produce the effect shown in the illustration—the faulting of one of the veins of the granite (Gr. 2) apparently without the other—the later faulting has taken place at an angle with the plane of section, being approximately along the direction of the strike of the branch vein inclined to the left, this also being along the direction of dip of the vein inclined to the right.

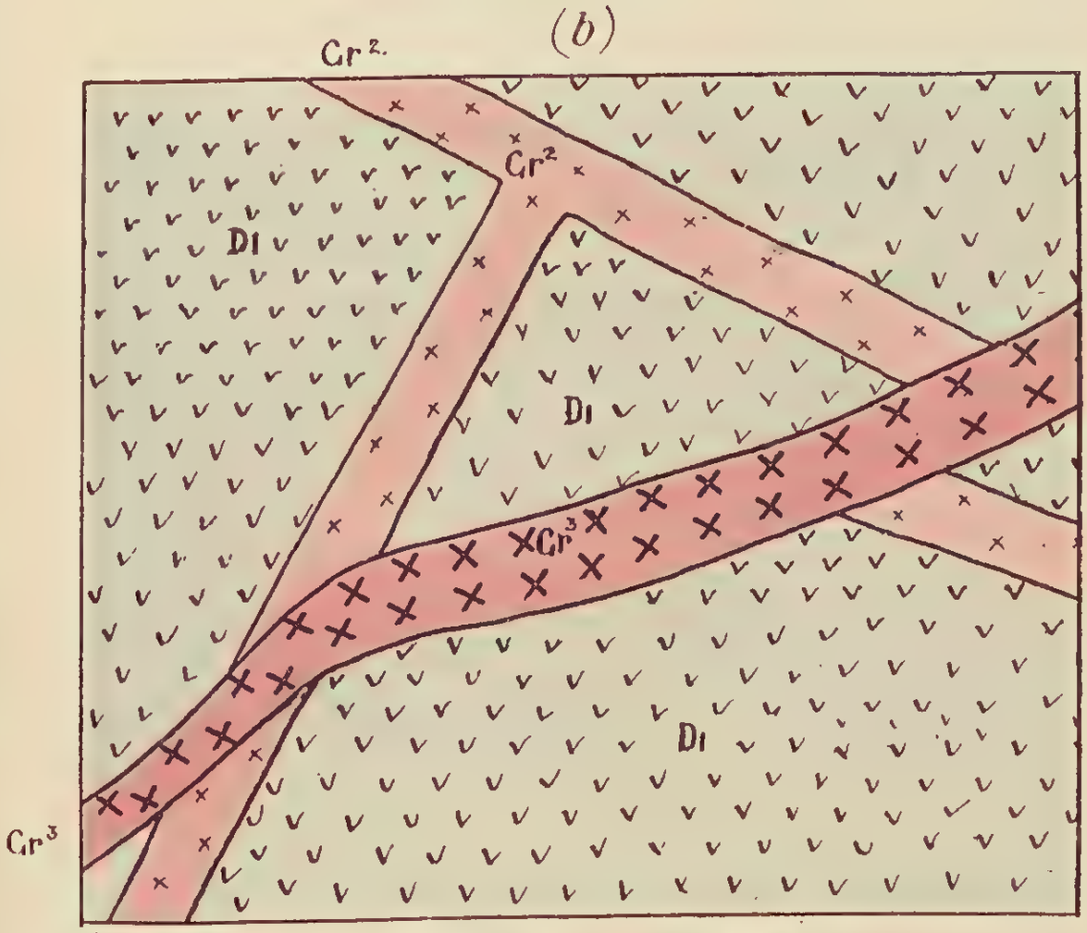
Scale: 1 inch = 5 inches.

(a)



Syenite Granite

(b)



Granite vein Diorite Granite vein

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PLATE 14.

Section in Railway Cutting (F).

A diorite (Di.) has enveloped a "horse" of felsite (Fe.), and across the felsite and diorite some vermiculite (*c*) granite veins—marked Vg.—have been formed. The shape of the veins of granite shows that openings had been made in the diorite, and that (*c*) granite subsequently filled them—the granite being an *after effect* of the disturbance of the diorite.

Scale: 1 inch = 1 foot.

Di
Vg
Fe
Fe
Vgx Vermiculite Granite
Fe Felsite
Di Diorite

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PLATE 15.

a

Section in Railway Cutting (G).

The diorite (Di.) has penetrated a fault in a large inclusion of felsite (Fe.). The faulting took place at an angle with the plane of section, and the upper portion (*a*) of the felsite has moved forward over the lower portion (*b*).

Scale: 1 inch = 18 inches.

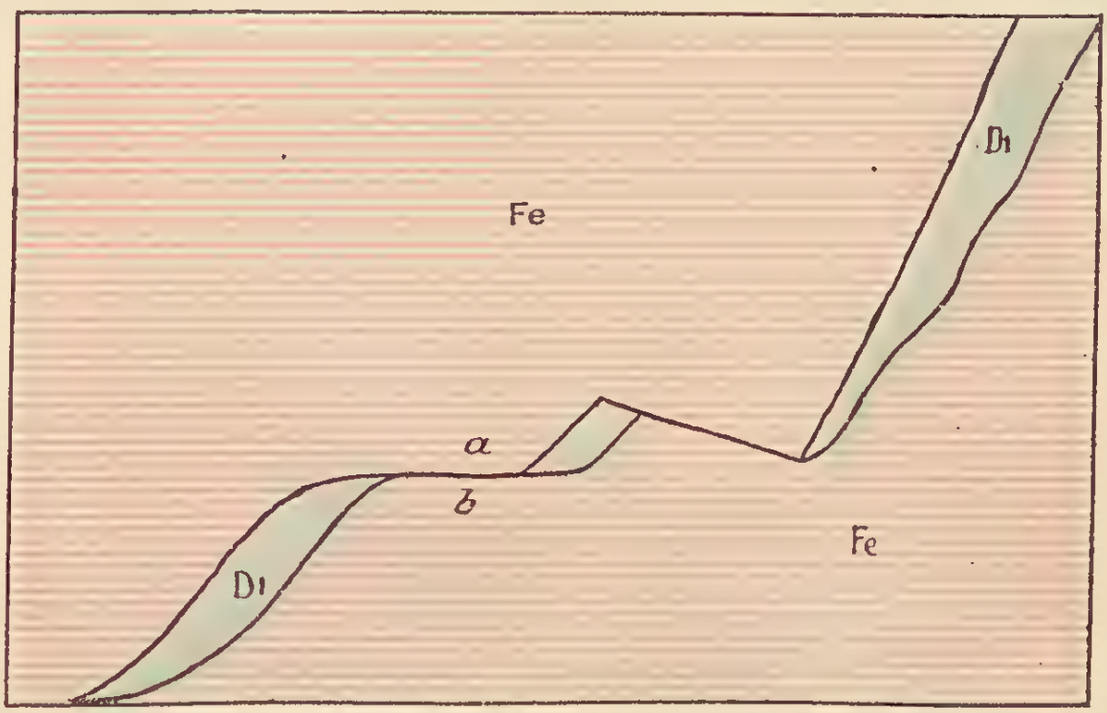
b

Section in Railway Cutting (G).

The section represents a vein of (*c*) vermiculite granite—marked Gr.—in the diorite (D). The contact of the granite and the diorite is sharply defined, and the junction of the two veins well shown. In the branch vein trending to the left the granite changes gradually to aplite (Ap.) and vermiculite pegmatite, the aplite being near the walls and the pegmatite along the centre.

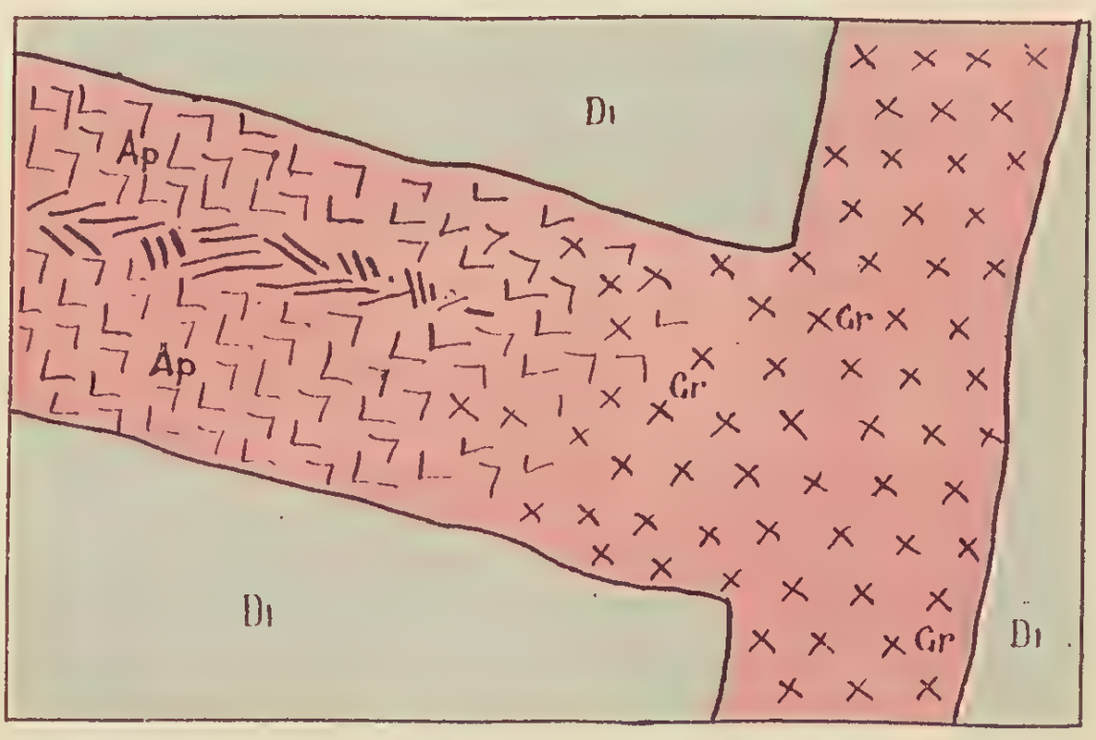
Scale: 1 inch = $1\frac{1}{2}$ inches.

(*a*)



Di *Diorite* Fe *Felsite*

(*b*)



Di *Diorite* Gr *Granite* Ap *Aplite*

VICTORIA.

PLATE 16.

Section in Railway Cutting (G).

In this section a mass of quartz-felsite (Q. Fe.) has been faulted, and the resulting fissure has been filled with a friction breccia.

Diorite (Di.) was then forced through the line of fault, forming small subsidiary horizontal offshoots in the quartz-felsite, and leaving the breccia on the footwall.

Subsequently a vein of fine-grained (*b*) or (*c*) granite—marked Gr. in the section—has formed across the diorite and the older rocks, the final stage being the simple dislocation of the formations, along the plane of which, and as the result of expansion and contraction, movements may now be taking place. On either side of this joint plane the rocks are compact and well cemented together.

Scale: 1 inch = 5 feet.

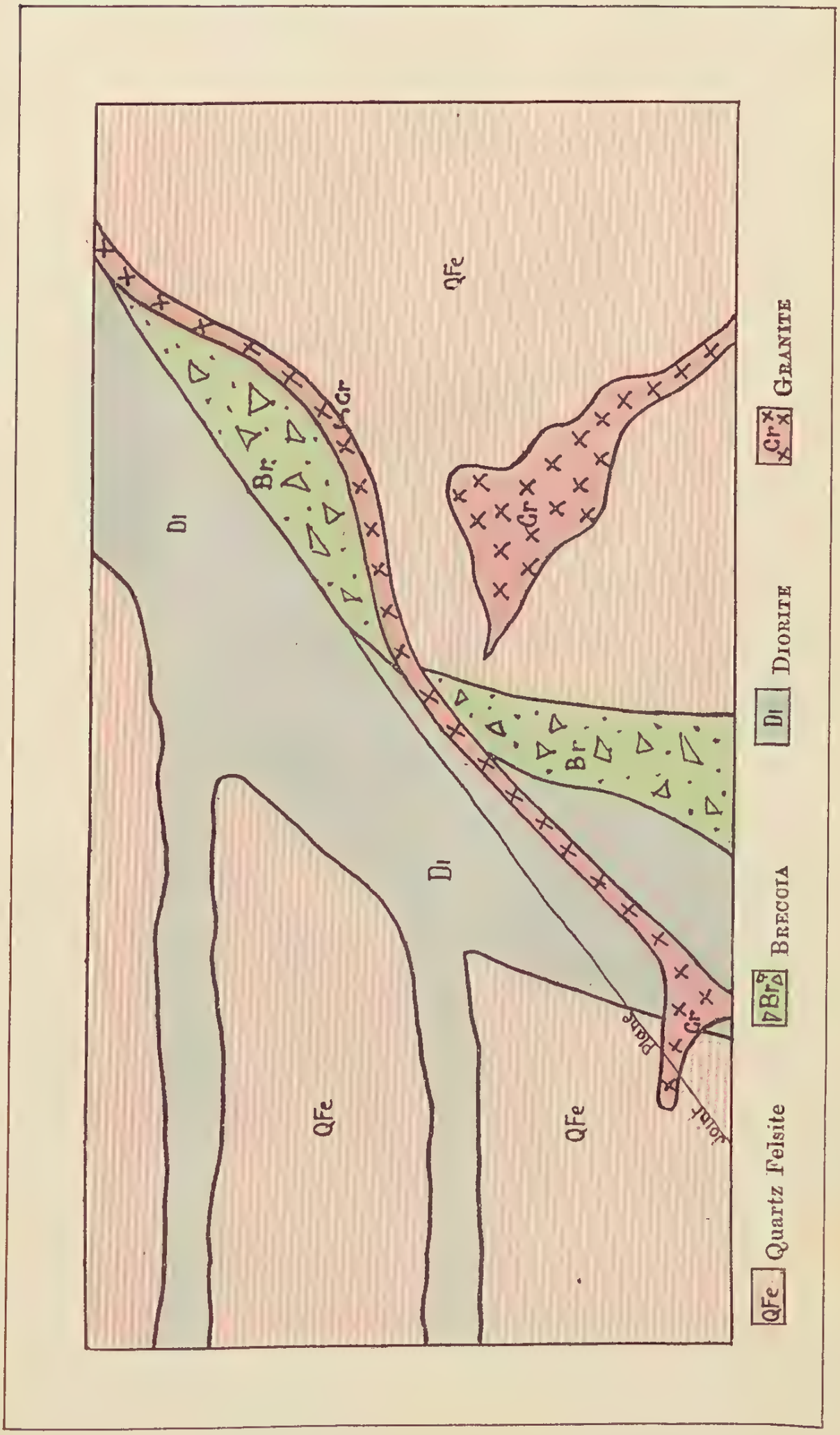

QFe
Di
Br
Cr
Joint
Plane
QFe Quartz Felsite
Br Brecoia
Di Diorite
Cr Granite

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PLATE 17.

a

Section in Railway Cutting (G).

The diorite in this section contains a vein of (*b*) vermiculite granite—marked Gr.—across both of which some leaders of (*c*) aplite and micro-pegmatite have been formed. The section is in some respects similar to the one shown on Plate 13, Fig. (A), but in the latter biotite is present.

Scale: 1 inch = 12 inches.

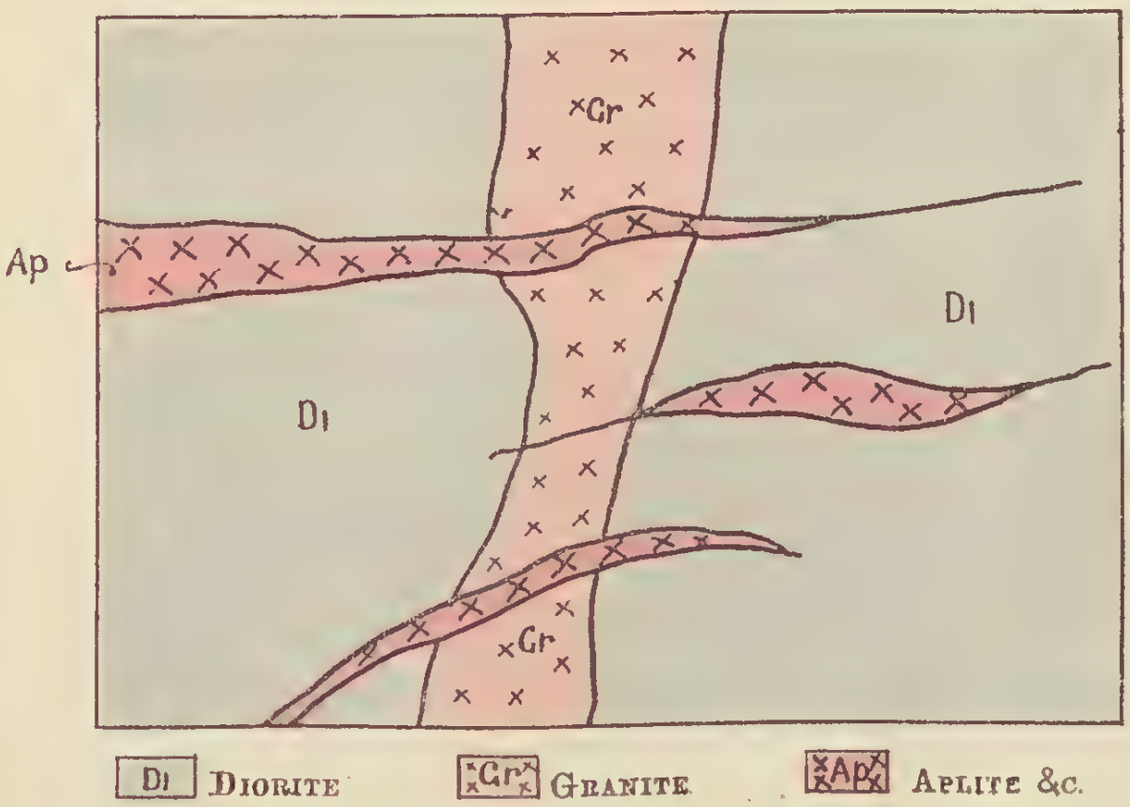
b

Section in Railway Cutting (G).

A vein of (*c*) aplite has formed across both diorite and the quartz-felsite. The aplite is fine-grained, but occasionally large flakes of vermiculite mica are to be seen in it. The vein is wide in the diorite, and gradually pinches out in the quartz-felsite. The gradual tapering of the walls of the vein indicate the diorite and quartz-felsite to have the same degree of plasticity at the time the fissure was opened across them.

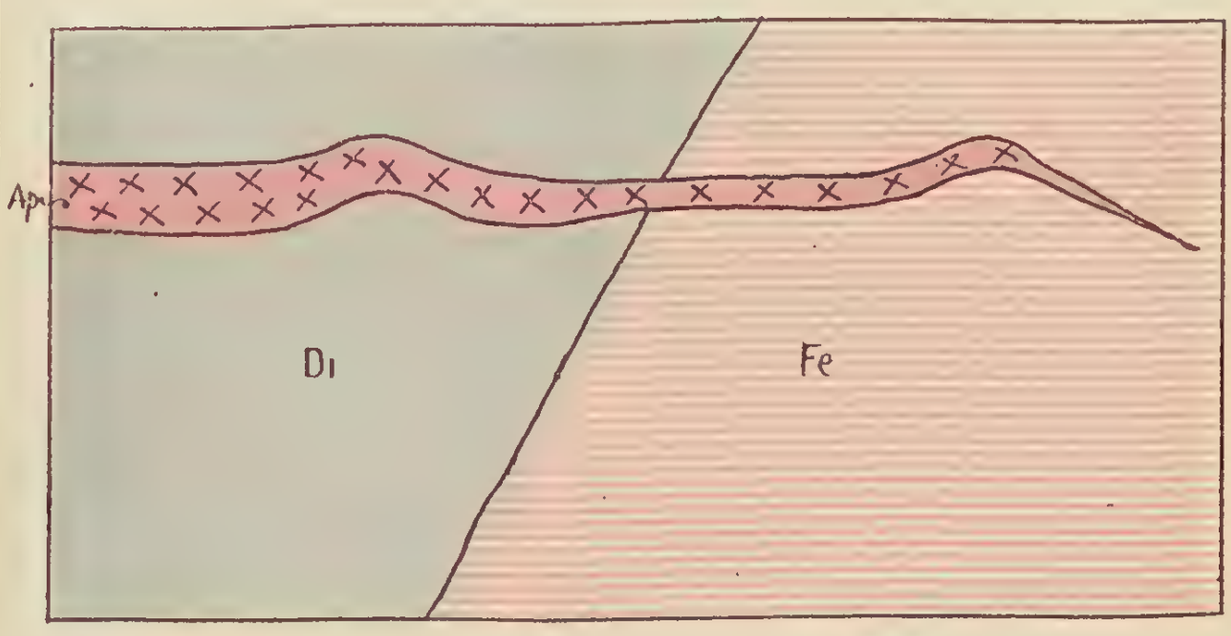
Scale: 1 inch = 2 feet.

(*a*)



Di Diorite Cr Granite Ap Aplite &c.

(*b*)



Di Diorite Fe Felsite Ap Aplite

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PLATE 18.

Section in Railway Cutting (G).

In the diorite a fissure has been opened, and then filled with a vermiculite granite. The section illustrates an apparent dislocation of the granite vein, but the faulting is only apparently so, the diorite being disturbed and the fissure produced before the granite came into existence. The section indicates that the diorite was sufficiently plastic to allow some portions to be extended without fracture—otherwise such a section would be impossible. The section is not uniformly to scale, but it shows all the salient points.

The same effect appears to have taken place in the quartz-felsite as well as in the diorite shown in Fig. *b*, Plate 17.

Scale: 1 inch = 14 inches (approx.).

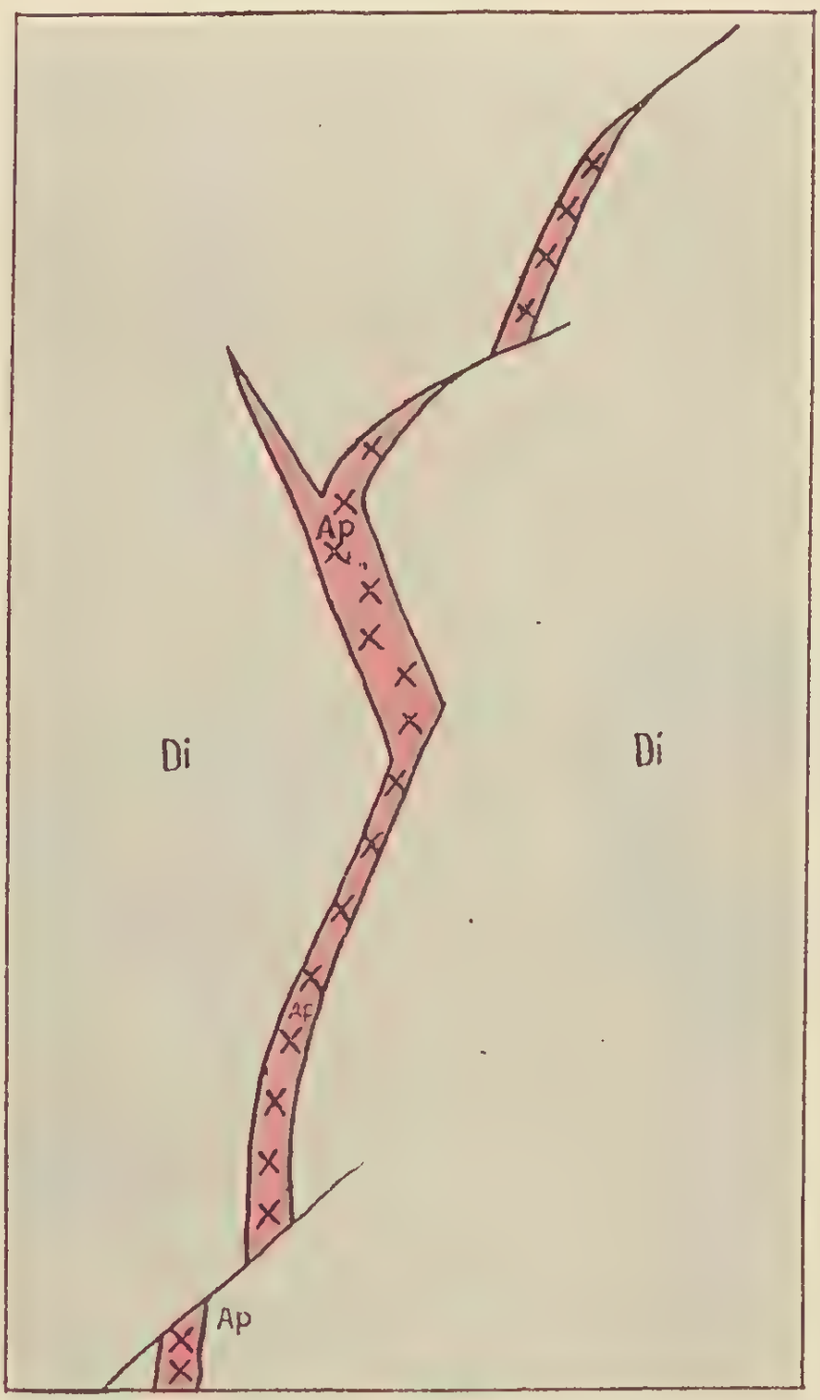
Ap
Di
Di
Ap
Di Diorite
Ap Aplite

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PLATE 19.

Diagrammatic Section.

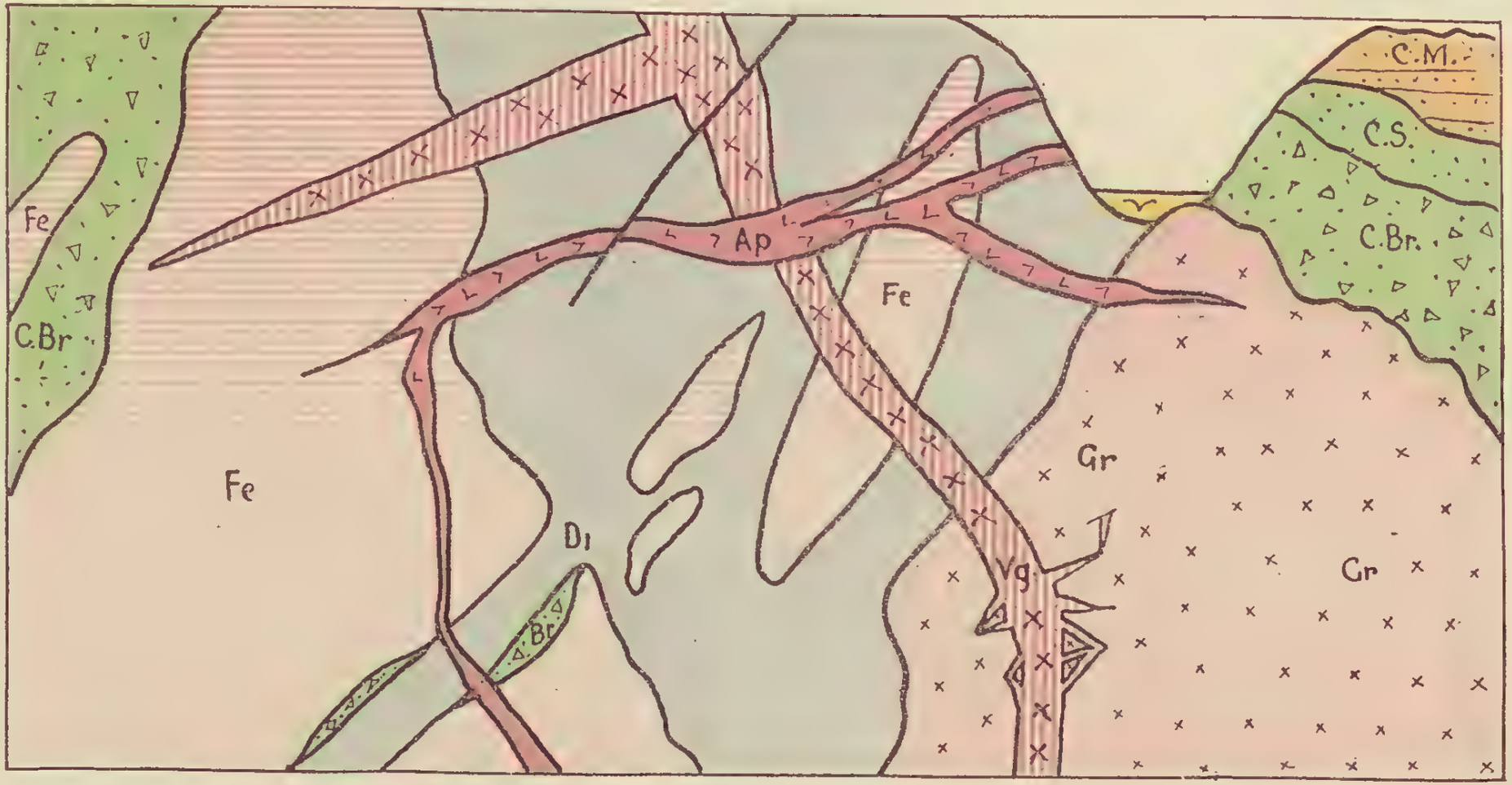
This illustration is a key or diagrammatic section showing the relation of the systems of rocks to one another at Moonmera.

The granite and syenite (Gr.) and felsites (Fe.) are the oldest rocks, the relation to one another not being known. Faults in the felsites have been formed, and in this a breccia (Br.) has accumulated. Another breccia (C. Br.), copper-bearing, and very massive, has formed above the granite. The diorite (Di.) dykes penetrate the felsites and disturb the breccia, but their intrusion of the old (*a*) granite and syenite has not yet been observed. The intrusion of the felsites by diorite has resulted in portions of the former rock being detached and included in the latter.

Since the diorite intrusions some veins of vermiculite (*b*) granite—marked Vg.—have come into existence in the massive (*a*) granite and syenite, and in the diorite and felsites. Veins of (*c*) aplite and pegmatite—marked Ap.—have formed across the (*b*) granite veins and the older rocks, and then were faulted. The copper-bearing breccia and granite have been denuded in places, resulting in the accumulation of a surface deposit of irregular copper-bearing sandstone (C. S.), and on which the Coal-Measure rocks (C. M.) have been deposited. Weathering of the Coal Measures above, and of the granite, syenite, diorite, felsites, and breccia below, have then taken place, and is in progress at the present time, while alluvial deposits containing gold have been concentrated in the watercourses leading down from the high country.

SEUM
VICT

Section



Fe Felsites
Br Breccia
Ap Aplite
C.S. Copper bearing Sandstones
Di Diorites
Gr Granite
Vg Vermiculite Granite
C.M. Coal Measures
C.Br. Copper bearing Breccia
Alluvium

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Queensland.

DEPARTMENT OF MINES.

Geological Survey of Queensland.

PUBLICATION No. 196.

RECORDS.—No. 2,

WITH OTHER NOTES.

(FIVE PLATES).

By B. DUNSTAN,
ACTING GOVERNMENT GEOLOGIST.

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V.—A SOIL SURVEY FOR QUEENSLAND.

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VII.—THE TESTING OF QUEENSLAND COALS.

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1905.

I.—GOLD DEPOSITS NEAR MOUNT UBI, WEST OF THE BLACKALL RANGE.

(PLATE 1.)

Many years ago, gold was found in small quantities close to Mount Ubi, and in other localities near the Mary River, west of the Blackall Range; but new life has been infused into the work of prospecting by recent developments, and a number of men are now vigorously searching for gold-bearing veins and alluvial deposits. An examination by the writer was made of the localities around Walli Creek and Chinaman's Creek, two tributaries of the Mary River, situated about 20 miles in a direct line westerly from Nambour, a station on the Brisbane-Gympie Railway Line, and about 25 miles south-westerly from Eumundi.

The country passed over in going to the field from Eumundi is mostly granite until Belli Creek is reached, where slate makes its appearance. The slate continues to Mount Ubi Station, near Tamlyn Creek, and on to Walli and Chinaman's Creeks, where granite reappears with diorite, both forming intrusions in the slate.

At Walli Creek, the site of some recent mining operations, syenite and diorite form a coarse breccia, the syenite occurring as a dyke in the larger mass of diorite, and including in itself fragments of the diorite. Polished sections of the breccia show it to be an attractive-looking building stone, the syenite being coarse in texture and mottled black and white, the fragments of the diorite being about two inches in diameter, of a bluish-black colour, and fine in texture. The rock is compact, free from decomposition, takes a fine polish, and could be obtained in large blocks.

Ottrelite slate is stated to occur *in situ* near the workings which have been sunk in prospecting for gold on Walli Creek. Fragments of the rock were picked up on the surface near one of the shafts, but its exact position could not be determined. Probably it occurs close to the junction of the slate with the syenite.

Quartz reefs, large and small, have been formed where the diorite, granite, and syenite are in contact with one another, and close to where they together are in contact with the slates. The reefs or veins which are gold-bearing, however, are very small, frequently narrowing to an inch in thickness and occasionally disappearing completely. They yield good prospects, but the syenite, granite, and diorite forming the walls are so hard, and the cost of mining consequently so great, that the yields of gold from such small veins would require to be several ounces to the ton to make the working of them profitable.

Other reefs exist in the neighbourhood, which could not be examined at the time; but they are said to be bold, strong reefs, sometimes four feet in thickness, but containing only traces of gold.

On Walli Creek, about two miles above its junction with the Mary River, three quartz veins have been prospected by Messrs. Booker and party, the positions of the various workings being indicated respectively on the accompanying plan (Plate 1) by the letters A, B, C, D, and E. At the position marked A, situated low down on the side of the hill and close to the creek, the country rocks are slate and syenite, between which there is a vein of quartz. The outcrop of the vein is exposed in the bank of the creek, and appears to strike north and south, with an underlie of about 60 degrees from the vertical, and having a general thickness of a few inches, but enlarged in one place to eight inches. The vein was searched for a short distance away from the outcrop in a shaft 28 feet deep, but it was not found, probably pinching out altogether.

Further up the bank of the creek, at the junction marked B, a trial hole and trench have been sunk in granite, exposing a quartz vein varying from an inch to six inches in thickness, and containing traces of gold, and having an underlie to the east-south-east at about an angle of 20 degrees from the vertical. Nothing was observed to encourage further prospecting on the vein.

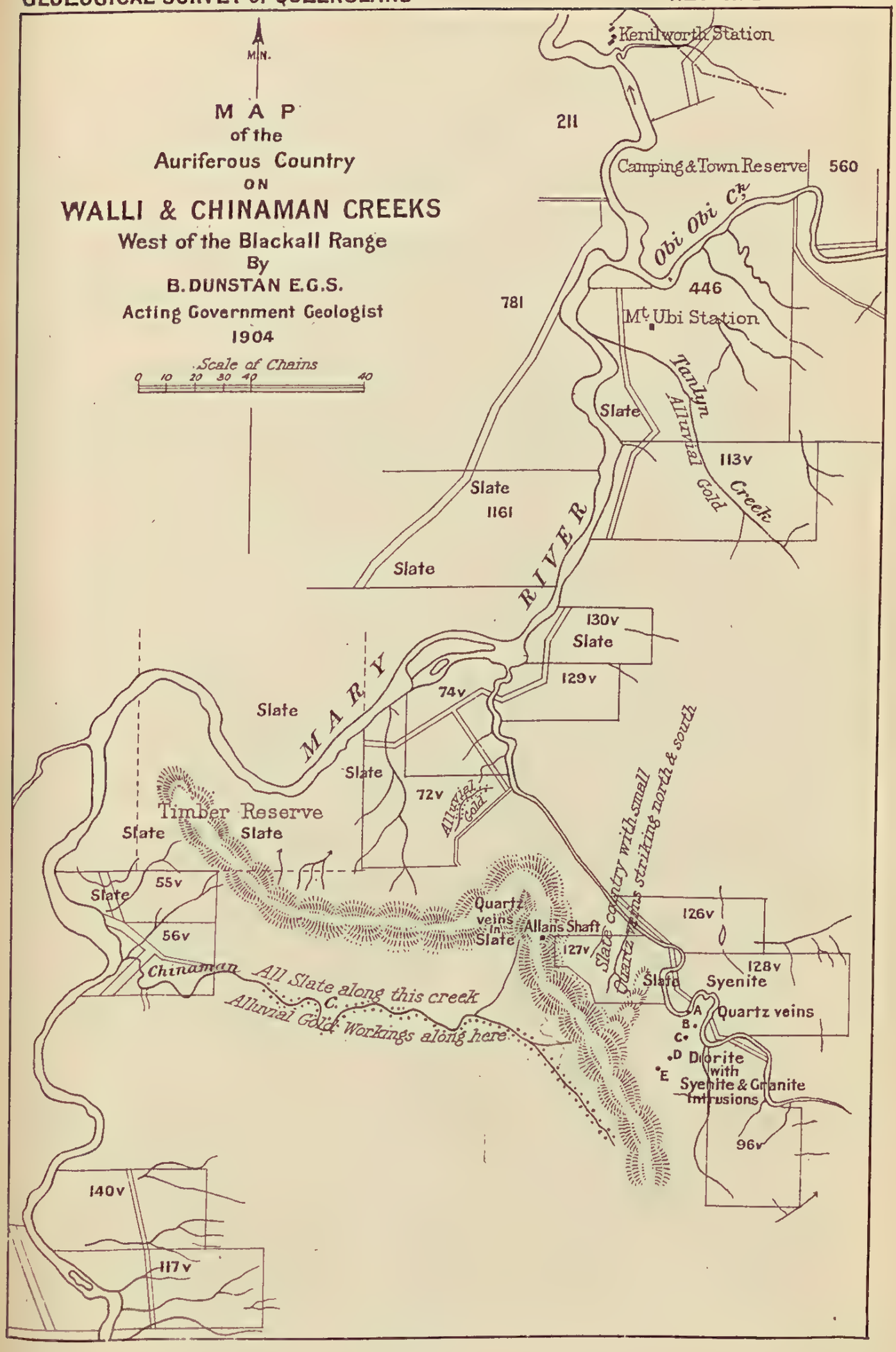
At the position marked C on the plan another excavation has been made, but the workings have fallen in, and have not been reopened.

A shaft was sunk at the place marked D, to a depth of 16 feet, but the vein expected to be found was not discovered, evidently pinching out just below the surface close to the position marked E, where the outcrop occurs. At E, another shaft on the hillside has been sunk in diorite to a depth of 18 feet, but without meeting the vein exposed on the surface. It is here that the syenite-diorite breccia occurs, mentioned above as being a fine ornamental building stone.

Close to the east side of the shaft at E, are other workings. They have exposed the vein which was once considered sufficiently encouraging to warrant this shaft being sunk, but with the results above stated. Copper carbonates occur in traces in this vein.

At Allan's mine, situated on the top of Allan's Ridge (*see* accompanying plan), about a mile north-east from Booker's workings, the country is slate alternating with subangular slate conglomerate, neither granite nor syenite being met with in the mine workings. A few hundred yards south of the mine, however, there is an outcrop of what appears to be a decomposed granitic rock, which, at some considerable depth below the surface, might be in contact with the veins which are known to occur here.

Five veins are exposed on the surface at this mine; all are very small, have a north and south strike, and are nearly vertical. No. 1 Vein has been penetrated in a tunnel driven to a distance of 76 feet, being met with at 66 feet. The vein is about four inches thick, with about three inches of a clay casing, and underlies at about an angle


M.N.
MAP
of the
Auriferous Country
ON
WALLI & CHINAMAN CREEKS
West of the Blackall Range
By
B. DUNSTAN E.G.S.
Acting Government Geologist
1904
Scale of Chains
0 10 20 30 40 40
Kenilworth Station
211
Camping & Town Reserve
560
Obi Obi Ck.
446
781
Mt. Ubi Station
Tanlyn Alluvial Gold Creek
Slate
113v
Slate
1161
RIVER
Slate
130v
Slate
129v
MARY
74v
Slate
Slate
72v
Alluvial Gold
Timber Reserve
Slate
Slate
55v
Slate
56v
Quartz veins in Slate
Allans Shaft
127v
Slate country with small Quartz veins striking north & south
126v
128v
Slate
Syenite
Quartz veins
A
B
C
D Diorite with Syenite & Granite Intrusions
E
Chinaman Ck.
All Slate along this creek
Alluvial Gold Workings along here
96v
140v
117v

of 10 degrees from the vertical. It is said to contain gold, but none of the stone has been taken out for trial. The tunnel was continued 10 feet beyond No. 1 Vein with the object of striking No. 2 Vein, but has not been driven far enough, the distance between No. 1 and No. 2 Veins on the surface being 20 feet.

No. 3 Vein, 20 feet away from No. 2, varies from two to seven inches in thickness, with an average of four inches. It was worked from the surface to a depth of 15 feet, and several tons of stone were removed, but the work ceased, and the mine is now abandoned and the workings fallen in.

No. 4 Vein, 15 feet away from No. 3, has been worked by a vertical shaft to a depth of 112 feet. The vein was discovered accidentally about eight feet from the surface, has an average thickness of five inches, but varies from half an inch to 15 inches. It is gold-bearing from top to bottom, and two tons, specially tested to prove its value, yielded over two ounces of gold to the ton. This certainly is the most promising vein on the field.

No. 5 Vein has been exposed in a shallow shaft about 40 feet north-west of the shaft on No. 4 Vein. It is about five inches thick in one place, but in a distance of a few feet it pinches to two inches, with several inches of a clay casing. Good prospects can be obtained from the stone by crushing and panning off in a dish.

The alluvial deposits are mostly confined to Chinaman's Creek, although gold was found many years ago at Tamlyn Creek and in one of the watercourses leading into Walli Creek. (*See* plan.) The Chinaman's Creek alluvial deposits, up to the time of the inspection, have only been prospected in a desultory manner, and little information could be gleaned as to the results which were obtained by the miners; but from the more recent operations of the Mount Ubi Gold Mining Syndicate, it would seem that while individual prospecting does not pay, the yields are satisfactory when the work is conducted systematically and on a large scale.

On Allan's Ridge, dividing Walli Creek from the heads of Chinaman's Creek, the veins and leaders are no doubt the source of the gold found in the alluvial deposits, as the rock pebbles and fragments forming the "wash" are identical with the rocks found on the ridge *in situ*.

It has been supposed that mining operations would be more successful if the alluvial gold were traced to the veins from which it has been shed, as the gold would be found to be more concentrated in the veins than in the alluvial deposits. While this might be so, it is more probable that the gold, shed from the numerous small veins and leaders which would not pay to work on Allan's Ridge, only becomes sufficiently concentrated to make the working of it practicable when it is washed into the alluvial deposits of the creek below.

2nd September, 1901.

II.—THE IRONSTONE OF MOUNT LUCY, CHILLAGOE DISTRICT.

(PLATES 2 AND 3.)

Mount Lucy is one of several prominent hills around Almaden, a station on the Chillagoe Railway Line, and has received attention at various times because of the large deposits of ironstone which are known to occur on it. Quite recently it was prospected by a miner for wolfram, who mistook the ironstone for this mineral, which it peculiarly resembles in some of its characters. The tests which have been applied, however, show that it does not even contain traces of this mineral.

Mount Lucy is situated about three miles westerly from Almaden, and is close to the coach road to Georgetown. Between Mount Lucy and Almaden, the hills are all composed of a hornblende-biotite granite containing aplite dykes, quartz leaders, and small irregular quartz masses. Further west of Mount Lucy the granite does not appear on the surface, the rocks exposed being shales, calcareous sandstones, and altered limestones. To the south and north, the prevailing rock is granite.

At the base of the mount, both on the eastern and southern sides, granite is exposed, and near the southern extremity the same rock rises up to within 50 feet of the top. From the latter position the granite has a northerly slope, and is further exposed in the gap between the two peaks (shown in Fig. 1, Plate 2), then sinks below the garnet rock forming the northern end. On the western side the granite is flanked by chert and quartzite, which has been formed, by alteration, from limestone.

From the occurrence of rocks, which are not ironstone, on all sides and on some parts of the top of Mount Lucy, it is clearly shown that ironstone forms a very small portion of its bulk.

The longitudinal section (Fig. 1, Plate 2) shows the position of the granite, the garnet-rock, and the ironstone capping; while the cross section (Fig. 2, Plate 2) showing the rock structures across the lower of the two peaks on the hill, indicates the granite to be the main rock, between which and the chert and quartzite on the western side, a mass of garnet-rock has been formed.

The outcrops of garnet-rock on the hill are partly decomposed, but some portions, which are unaltered, on examination prove to be the garnet variety, Andradite. The garnet-rock has become disjointed in many places, and the cracks have been filled with silica, while much

Mt LUCY SECTIONS

Fig.1

Longitudinal Section

Showing the (1) Granite, (2) the Sedimentary Rocks,
(3) the Garnet Rock & (4) the Ironstone Cap.

Length of Section about 400 feet. Height of Southern Peak about 150 feet

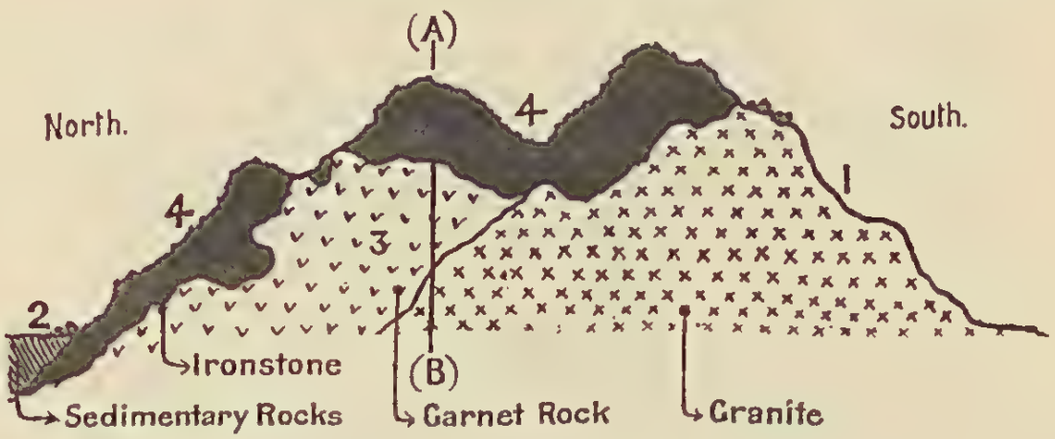
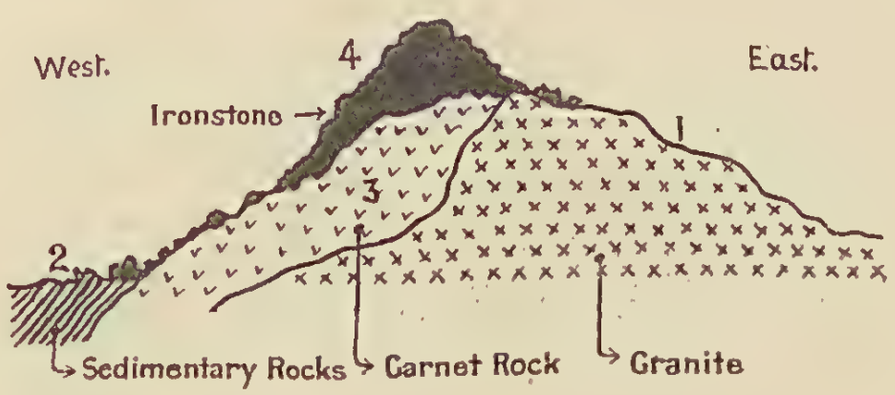


Fig.2

Cross Section on A B (Fig 1)

(Length of Section about 300 feet)

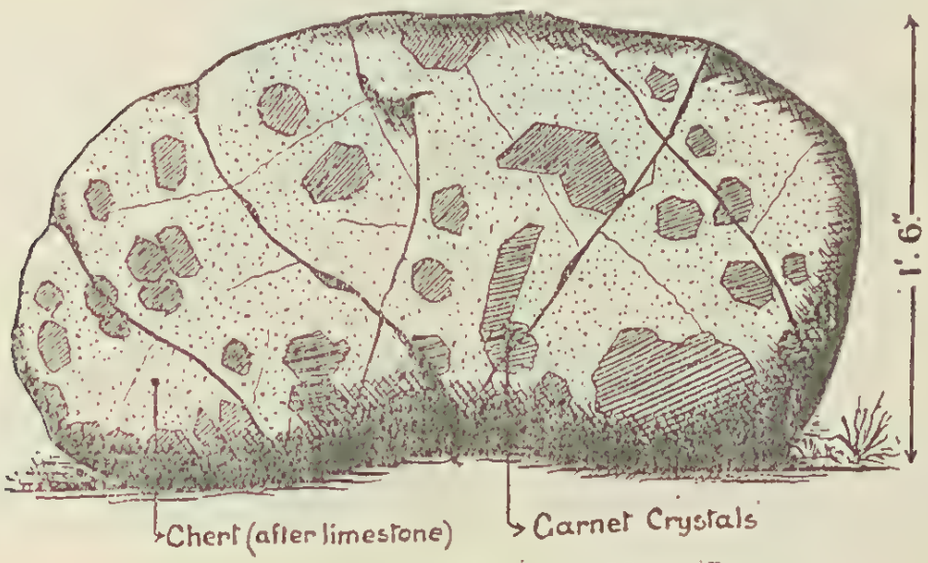


of the garnet has been changed to magnetite. In this condition the rock has been subjected to exposure and to surface leaching, and the remaining portions of garnet-rock, while retaining their form where crystallised, have been to a great extent converted into friable magnetite.

The occurrence of garnet in association with limestone and granite has previously been referred to by the writer in a description of the rocks at Barmundoo, in the Gladstone district,* and of those at Chillagoe.† Further reference need not, therefore, be made here on their general characters and their relations to one another.

An additional feature, however, has been noticed in the occurrence of the magnetite in chert, the former being a pseudomorph after garnet, the latter resulting from the alteration of limestone. Boulders of this mottled rock occur in the northern end of Mount Lucy, a sketch of one being here reproduced. (Fig. 1.) They show that where the contact of the limestone with granite takes place, the andradite garnet

Fig. 1.



Boulder of Chert and Garnet.—Mount Lucy.

has formed, frequently as large massive crystals, and that before the alteration of the garnet took place, the limestone was altered to chert and quartzite, the garnet altering to magnetite at a subsequent stage.

The limestones do not outcrop close to the mount, but are exposed about half a mile to the west, where they are somewhat silicified and coarsely crystalline. Closer to the mount the rocks are soft shales and calcareous sandstones, while at its base the cherts are to be found as small rugged outcrops exposed several feet above the surrounding soil.

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* Geological and Mineral Features of Diglum Creek, Barmundoo, Gladstone District, &c. By B. D. Brisb.: By Auth., 1901, page 12. (G.S.Q., P. No. 162.) (Bull. No. 16.)

† "Some Chillagoe Geological Notes," in Ann. Prog. Report of the Geol. Surv. for 1900. (G.S.Q., P. No. 156.)

No opportunity has been afforded to thoroughly examine these cherts, so at present no opinion can be formed as to whether they contain any microscopic organisms.

Wollastonite, with chert, forms very conspicuous outcrops, the light colour of the former and the dark colour of the latter being very noticeable features. The wollastonite, in weathering very easily, helps to exaggerate the rugged structure of the chert, which stands out boldly, while the wollastonite is worn down into crevices and hollows. A sketch of this is shown in Fig. 1, Plate 3.

All the data accumulated during the examination indicate the ironstone to be only a shallow deposit, and there is no evidence to show that it forms anything more than a cap to the mountain. The ironstone is, *in situ*, confined to the top, having its highest position at the south end, and gradually falling towards the north end. There is no indication of its extending below the surface, except, perhaps, where the ironstone is close down to the level of the plain on the northern end. (*See* Fig. 1, Plate 2.)

The total length of the mount is about 900 feet, while its width at the base is about 250 feet, the height above the surrounding country being about 150 feet. The average thickness of ironstone is roughly estimated to be 50 feet, its width to be about 50 feet, and its length about 700 feet. With these dimensions the number of tons of ironstone on the cap of Mount Lucy would be about 250,000 tons. Adding to this the large quantity strewn all around the sides of the mount, which amounts to about 100,000 tons, there will be a total of 350,000 tons, a fair estimate of the quantity of ironstone actually in sight.

The mineralogical characters of the ironstone show it to be between magnetite and hematite. Its crystalline form is that of magnetite, while in colour and streak it resembles hematite. Some of the crystals may be isomorphous after garnet, but there is no doubt that some of the magnetite has been formed without being an alteration product of this mineral.

28th June, 1905.

MT LUCY MINERALS

Fig. 1
Weathered mass of Chert and Wollastonite

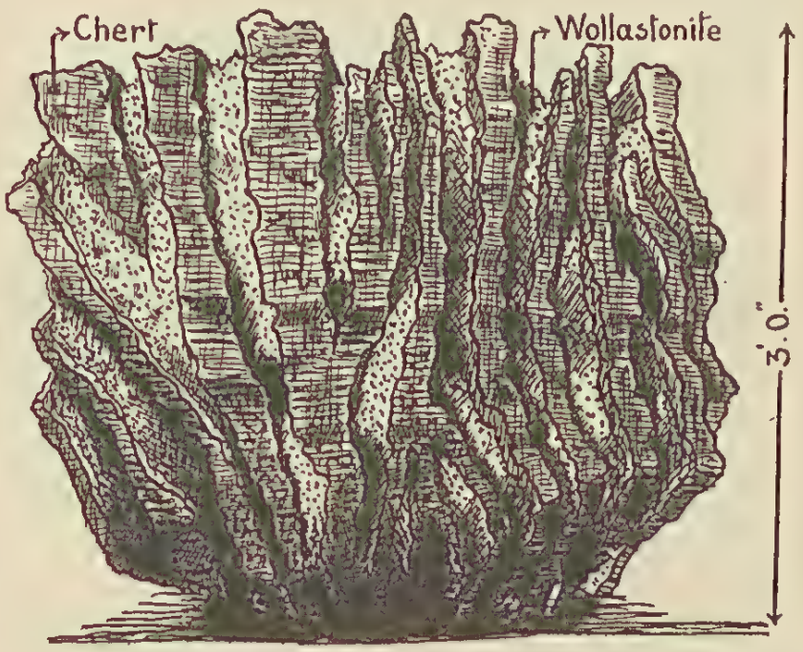
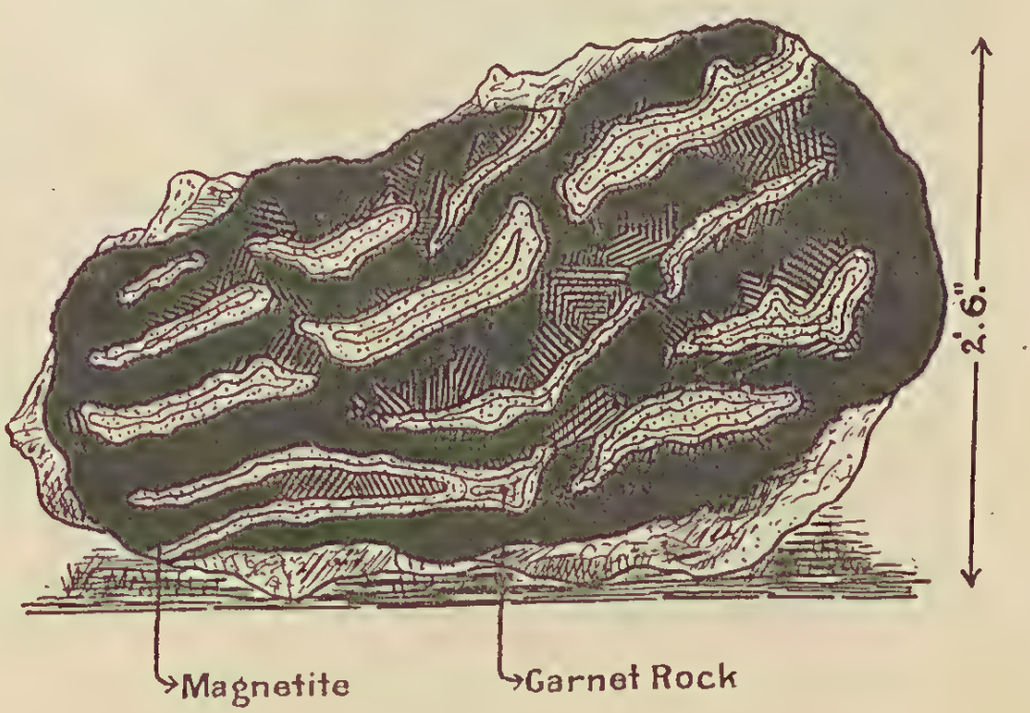


Fig. 2
Boulder of Magnetile showing cleavage
with remnants of Garnet rock partly decomposed



III.—TESTING SAMPLES FOR PROSPECTORS.

Samples of ore are constantly being received by the Geological Survey Office from miners and others who desire to know the commercial value of the minerals they contain, but the conditions to be fulfilled are not generally observed, neither are the samples, except in rare instances, properly prepared for assay.

Minerals and rock specimens requiring simple classification are examined unconditionally, but a stipulation is made that those who require fire assays or chemical analyses of minerals should be prospectors, and also that the samples are from localities which are not well-defined centres of mining development, but rather where the country is being developed after having been abandoned, or where previously no prospecting work has been undertaken.

These conditions are objected to by many, but our desire is simply to assist in the work of mineral discovery, and this object is attained by attending to the requirements of the prospector. When assays are made for buyers and sellers of parcels of ore, or for the purpose of company flotation, the schedule charges are insisted upon. The privilege of obtaining free assays from the Department is no doubt abused to some extent, but this evil might be tolerated in view of the good results which accrue in so many other ways.

There is another condition which most prospectors take exception to at first, but which, nevertheless, is quite in reason—that is, making known the locality from which the samples were obtained. An average of about 10 per cent. of the samples tested give returns which show that the minerals they contain are in payable quantities, the 90 per cent. being of no present commercial value. Of the latter, about 60 per cent. are not even of prospective value, the remaining 30 per cent. possibly being valuable in years to come—when facilities for mining development and for transport become better, and when some of the minerals now worthless will no doubt be found useful in some of the manufacturing industries.

It is also very important that the absolutely valueless mineral deposits—the 60 per cent.—should be recorded to indicate the localities where prospecting work has been futile. It is now known that duplicate assays have been made of minerals from the same locality, separate parcels being sent by different individuals, each of whom, perhaps, was not aware that others had furnished similar samples to be tested. Were particulars supplied regarding the localities, this duplication of assays, and the expense incurred, would be avoided.

Another advantage resulting from the possession of this information would be in enabling advice being given to miners who wish to

further prospect a mineral deposit previously examined. Miners could be given the results of previously made assays and tests of mineral deposits they propose to operate upon, if such have been made, and this might result in encouragement being given to further development, or, on the other hand, might indicate that such work would entail waste of labour and money. It has frequently happened that a party of miners, in reopening an abandoned mine, would not have started operations had they known beforehand the result of assays made for those who previously worked the mine.

The preparation of samples for assay and for mineral classification is quite simple, and should hardly need a description. Nevertheless, parcels of stone are frequently received which consist perhaps of a couple of pieces, and which cannot be considered average samples. For the *determination or classification* of any mineral species, good clean pieces are desired, and the quantity should not be too small. In the *estimation of quantities*, such as the percentage of copper or tin, or the number of ounces of gold or silver per ton, it is necessary to carefully prepare the samples. Many will break off a piece of stone from a lode and from that expect a result indicating the average yield of the whole mass, and fail to see that in such a test rich stone may be overlooked. On the other hand, the specimen might give a rich return, and will perhaps result in money being spent in developing the deposit of mineral, after which it might be found that the bulk of the stone is either barren or too poor to pay. The man who supplies the funds for carrying on operations might think the prospector had deceived him as to the quality of the stone, or both might think the stone was not properly tested in the laboratory, and put the blame on the assayer.

The better method of sampling is to take stone from all exposed places on the lode, which must then be crushed and mixed, and afterwards quartered. One quarter is then more finely crushed and again mixed and quartered, the operation being repeated until the bulk is reduced sufficiently to make a small finely-crushed sample weighing two or three pounds. When this is not practicable, very small pieces—say, fifteen to the ounce—should be chipped off all exposed places, from which a sample is taken after finely crushing and mixing. This will give a fairly satisfactory result, although not so accurate as the former method. It would also be as well to include a large chip of the mineral as a guide to its classification.

Attention should also be given to the forwarding of samples. They should have some distinguishing mark, and this should be referred to in the letter of advice. Many samples received are without marks, which causes confusion, and the greatest care has to be exercised in identifying post-marks, or in comparing handwriting, in order to avoid samples from one individual being mistaken for those sent by another.

23rd January, 1905.

IV.—MONAZITE IN QUEENSLAND.

For some time past monazite has been known to occur in the beach sands on the coast of Queensland, and numerous samples have been sent to the Geological Survey Office for the examination of their monazitic contents.

Many years ago the beach sands near the mouth of the Tweed River were prospected for gold, and in a small quantity of the sand purchased by this office from Mr. Dwyer there were detected platinum and osmiridium, a concentrated sample of which yielded on assay 26.12 per cent. of platinum and 40.02 per cent. of osmiridium. In 1903 another sample, purchased from the same miner, was found to contain a monazite-like mineral, alluvial gold, 2.16 per cent. of platinum, and 1.61 per cent. of osmiridium. During March and May, 1904, other samples of beach sand from near the mouth of the Tweed were submitted for examination, the first one received with the intimation that it was thought to contain monazite. In May an inspection of the beach sands north of the entrance to the Tweed River was made by Mr. Ball, who obtained samples in which the Government Analyst detected the presence of 4.3 per cent. of earths of the cerium group (calculated as oxides and including 0.4 per cent. of thoria). Subsequently information was received that the beach miners were obtaining tinstone, a concentrated sample of which yielded 54 per cent. of tin. This, on a later inspection, was confirmed by Mr. Ball, whose report has already been published.*

The presence of the monazitic sands at the Tweed has resulted in other parts of the coast being prospected, and a bulk sample from the mouth of the Johnstone River, obtained through Dr. MacDonald, of Geraldton, was forwarded by the Department of Mines during March, 1904, to the Imperial Institute in London for examination.

The locality from which this sample was taken, according to Mr.

* Q.G.M. Jour. Feb., Vol. vi., 1905. Pp. 62-67.

John Cameron, is inside the entrance to the river on the south side, and is shown on the accompanying sketch plan. Mr. Chap-

Fig. 2.

PLAN SHOWING POSITION OF MONAZITIC SANDS, JOHNSTONE RIVER.

(Monazitic Deposits along dotted line from A to A.)

man, who has been examining the beach deposits in the neighbourhood of the Johnstone River, states that there are no iron-bearing sands on the beach on the north side of the river, and he is of opinion that the ocean beach on the south side of the entrance would yield more heavy minerals than the locality from which the analysed sample was taken.

This concentrated material was then analysed in the Scientific and Technical Department of the Imperial Institute, and gave the following result:—

Silica, SiO_2	7.59 per cent.
Titanium oxide, TiO_2	44.59 ,,
Zirconium oxide, ZrO_2	1.06 ,,
Thorium oxide (thoria), ThO_2	0.23 ,,
Alumina, Al_2O_3	1.46 ,,
Yttria, Y_2O_3	0.10 ,,
Ferric oxide, Fe_2O_3	1.24 ,,
Ferrous oxide, FeO	36.38 ,,
Manganous oxide, MnO	2.79 ,,
Copper oxide, CuO	0.05 ,,
Lime, CaO	0.79 ,,
Magnesia, MgO	1.16 ,,
Cerous oxide, CeO	0.46 ,,
Phosphoric acid, P_2O_5	0.41 ,,
Niobic oxide, Nb_2O_5 } Tantalic oxide, Ta_2O_5 }	0.78 ,,
Moisture	0.8 ,,

These results indicated the presence of the minerals ilmenite, quartz, garnet, zircon, magnetite, monazite, and possibly tantalite in the "concentrate," and this was confirmed by microscopical examination. The proximate composition of the concentrated mineral may, therefore, be taken as—

Ilmenite (Fe, Mn, Mg)O, TiO_2	84.0 per cent.
Magnetite, Fe_3O_4	1.8 ,,
Zircon, ZrO_2, SiO_2	1.4 ,,
Quartz, SiO^2	4.4 ,,
Garnet and other silicates containing alumina, lime and magnesia	5.0 ,,
Monazite*	1.2 ,,
Tantalite	0.9 ,,
Moisture	0.8 ,,

* A portion of the thoria may be present as thorite (thorium silicate).

The only constituents of the sand likely to be of immediate commercial value are the oxides of thorium and cerium. The amount of thoria present in the "concentrate" is only 0.23 per cent., and in the crude mineral 0.05 per cent., and the proportion of cerium oxide 0.46 per cent. in the "concentrate" and 0.10 per cent. in the original sand.

Material as poor in these oxides as the present sample, or even the "concentrates" prepared from it at the Imperial Institute, would probably not prove remunerative to work under present conditions. At the present time the value of the "concentrates" as a source of thoria would probably not exceed £2 10s. per ton, assuming that it would pay to extract thoria from such material.

The percentage of thoria could doubtless be increased by removing the magnetite and ilmenite by magnetic separators, but it would seem hopeless to attempt to compete by these means with the Brazilian monazitic sands, which constitute at present the principal commercial source of thoria; these, in the concentrated form in which they are exported, yield from 5 to 8 per cent. of this oxide. A mineral found in Ceylon, and discovered to be a new mineral (thorianite) by analysis at the Imperial Institute, contains as much as 70 to 80 per cent. of thoria, and therefore is of greater value than any other source of thoria. The quantity available appears, however, to be small.

The percentage of cerium oxide in the Queensland sand is double that of the thorium oxide, but the demand for the former is very limited, since, in the construction of mantles for incandescent gas lighting, only 1 per cent. of ceria is used to about 99 per cent. of thoria.

Titanium oxide is present in the concentrate to the amount of 44.59 per cent., corresponding to 9.27 of the crude sands.

* * * * * * *

The only other constituent of the sand likely to possess commercial value is the tantalum. Recent experiments have shown that this

metal can be used as a filament in electric glow lamps, and such lamps are now on the market. The "concentrate" prepared from the Queensland sand contained, however, only 0.78 of tantalic and niobic oxides, so that it is improbable that this material could be used as a commercial source of tantalum in competition with the other richer tantalum minerals available.

During an examination by the writer, in December, 1904, of the wolfram fields of Northern Queensland, tests were made of a heavy mineral occurring at several localities on the Walsh and Tinaroo Mineral Fields, which the miners thought might be scheelite, but which blowpipe and other tests indicated to be monazite or some mineral closely allied to it. As the mineral in two of the localities occur *in situ*, close attention was paid to its mode of occurrence. The mineral was first pointed out by Mr. MacMahon, a miner, who wanted to know if the heavy brown mineral being found in small quantities with alluvial tin around Fossilbrook was of any value. Later on, the monazite was identified at Bamford, Old Wolfram Camp, Emuford, Ord, and Coolgarra, occurring only in traces on some of the fields, while in others its presence in quantity constituted a serious hindrance to the cleaning of the wolfram associated with it.

The monazite has only been found *in situ* where wolfram deposits pay to work, so probably other richer deposits are known which have been passed over because of the absence or scarcity of wolfram in them.

The miners have thrown it away as worthless because the wolfram dealers, knowing it was not scheelite, have refused, repeatedly, to take it at any price. A wolfram-mining venture in one place failed, and the mine was abandoned, because the supposed scheelite could not be sold, while at another locality a wolfram miner had accumulated a large quantity of it, and, without considering its prospective value in other respects, was pleased to be told, in time, that it was not scheelite, thus saving the expense of dressing, bagging, and forwarding by rail to Cairns.

Later on, further details of the monazite deposits will be given in connection with the report being prepared on the wolfram fields of Queensland, but in the meantime some information concerning it may be here given for the benefit of those interested in the matter.

The colour of the mineral varies from deep reddish-brown, clove-brown, light-brown, to light brownish-yellow, presenting frequently the colour and lustre of "resin" tinstone. It is semi-translucent on the edges and in thin flakes, but otherwise is opaque. The lustre is somewhat resinous on a fractured surface, but is glassy or shining on fresh cleavage faces. It has distinct cleavages in three directions (as well as others not easily recognised), somewhat resembling in appearance the rhombohedral cleavage of calcite.

With a knife blade monazite can be scratched without difficulty; but, being rather brittle, and separating readily into cleavage flakes, some specimens crumble when scratched, and give the impression that the mineral is rather soft.

The specific gravity is high, being 5.04 (equivalent to iron pyrites); and, while this makes it troublesome to separate from the wolfram in the dressing of that mineral, it affords a very ready means of distinguishing it from most other minerals otherwise resembling it.

Topaz, scheelite, and felspar are minerals commonly found with the wolfram, and by the novice may easily be mistaken for monazite. The topaz may be known by its extreme hardness (being scratched with a knife), but otherwise, in rough specimens, particularly in colour, it has been observed to much resemble monazite.

The scheelite, which may be scratched with a knife, is but a little heavier than monazite and sometimes resembles it in colour, but the three distinct cleavages are absent. The felspar, in its colour and cleavage, may be mistaken for monazite, but it has not a resinous lustre; besides, it is so much lighter in weight, and is not so readily scratched with a knife. The blowpipe reactions are also useful tests in distinguishing these four minerals from one another, but the tests cannot be applied by those having no experience in blowpipe work.

The monazite was observed to occur in pure crystalline masses, sometimes several pounds in weight, and also in small cleavable grains. Both forms are irregularly disseminated in quartz, black mica (biotite), and chloritic mica, and are in association with wolfram, molybdenite, scheelite, tinstone, fluorspar, and mispickel. With the exception of wolfram, these associated minerals are only in comparatively small quantities.

The deposits containing the monazite are in granite country, but close to quartz-porphyry and slate. In the granite, and also at the junction of this rock with the porphyry and slate, irregular masses of greisen have been formed from the alteration of the granite, and it is in this, following closely the behaviour of the wolfram, that the monazite deposits are to be found.

The size of the monazite masses and the percentage of the mineral in the greisen lodes, are abnormally high when compared to foreign monazite deposits, and no doubt a large quantity of it could be obtained as a by-product in the mining of wolfram.

The most important foreign monazite deposits are in Brazil and in the State of South Carolina, United States. The Brazilian mines in 1902 produced about 811 tons of monazite sand, having a percentage of from 5 to 8 per cent. of thoria (the substance so valuable in the manufacture of incandescent gas mantles), the total value being

£16,898 19s. 2d., or about £20 16s. per ton. The South Carolina mines in 1903 produced 340 tons of monazite sand, valued at £13,464, or about £35 per ton.

A preliminary analysis of a clean sample of the Queensland monazite yielded 66 per cent. of cerium and other rare earths (Government Analyst). A commercial sample, uncleaned and without any concentration, yielded 2.6 per cent. of thoria, and 56.1 per cent. of oxides of the cerium and yttrium groups (Basil Turner). This sample, if concentrated or picked to obtain clean mineral, would probably yield 3 per cent. of thoria, which at, say, £5 per unit, would show the monazite to be worth £15 per ton. This return certainly warrants further attention being paid to the occurrence of the deposits as an increase of 2 per cent. of the thoria—making 5 per cent.—would be worth about £8 per unit, or about £40 per ton of monazite.

17th May, 1905.

V.—A SOIL SURVEY FOR QUEENSLAND.

The advantages which would result from having a survey made of the soil areas in certain parts of Queensland have been so satisfactorily demonstrated that nothing need be stated here in support of the proposition made that one should be undertaken. Something, however, may be added regarding the carrying out of such a project.

A soil survey, it must be clearly understood, must be very thorough in its work if good results are to be expected of it, and this can only be achieved by its establishment on a proper basis, and by the employment of men having a scientific training.

American practice in this respect has been very successful, and may be taken as a guide for us to follow. There, it has been shown, the work of collecting information is being performed by a staff of men who are closely in touch with a geological and mineral survey, and in some of the States all the specialists in geology, mining, agriculture, &c., comprise the staff of what is termed a geological and natural history survey.

Economy and general utility have been made the basis of the amalgamation, as it was found that information bearing on soils, minerals, rocks, physical features, timbers, &c., could be collected by the one survey party, leaving much of the details to be worked out in the laboratories by the mineralogist, petrologist, palæontologist, chemist, botanist, entomologist, and other specialists.

In our own Geological Survey most of the work of the staff is connected with the mining industry, and the increasing demands made on it in connection with the examination of mines and mining districts leaves no time to devote to work of a more general character. With the proposed soil survey, and the existing geological survey, however, the nucleus of a geological and natural history survey could be established, which in course of time would so develop that the work of its officers would be applied to other industries besides mining and agriculture.

A reference to this subject was made in last year's Progress Report of the Geological Survey,* showing that information should be accumulated about all mineral products which could be utilised for industrial purposes, such as mineral fertilisers, pottery and brick-making material, ornamental and building stones, cement-making material, mineral lubricants, and mineral paints.

26th February, 1905.

* Ann. Rep. Dept. of Mines, 1903, p. 172.

VI.—BORING FOR COAL NEAR TOWNSVILLE.

(PLATE 4.)

An inspection by the writer was made recently of the developments in coal prospecting close to Townsville, on the Northern Railway Line, and while engaged on this work some data was accumulated regarding the position and depths of some of the bores put down many years ago.

In a report on coal near Townsville,* Dr. Jack refers to the existence of coal measures in a railway cutting at Stewart's Creek, 6½ miles from Townsville, on the railway line, in which a small seam of coal was exposed. The analysis of a sample of this coal gave the following results:—

Analysis of Small Coal Seam, Stewart's Creek Railway Cutting.

Volatile matter (including water) ...	53·84 per cent.
Fixed carbon	37·87 „
Ash	8·29 „
	100·00

The remarks appended show that "the coal is of a remarkably high quality, whether for gas-making or steaming purposes. Should a similar seam be discovered of workable thickness, a great impetus would be given to the manufacturing industries of the North."

In 1888 another report (unpublished) was made by Dr. Jack on the same subject, having special reference to some bores sunk at Stewart's Creek for the purpose of testing the measures containing the small seam of coal referred to above.

The examination made by the writer included an inspection of the various bore sites and the coal-measure outcrops, together with the eruptive rocks in the vicinity, and the opinion was formed that the bores have been put down too close to the eruptive rocks, and that it would have been better to have sunk further north-west, even if the drift, which has been found to be of considerable thickness in the bores, were expected to be deeper before the measures were penetrated.

The rocks exposed on the surface near the railway show that shales and greywackes are interbedded with sheets of basalt and with volcanic tuffs containing impressions of *Glossopteris*, the disturbed conditions which generally prevail indicating that if a coal seam were found it would prove to be unworkable.

* Geological Observations in the North of Queensland, 1886-7. R.L.J. Brisb.: By Auth., 1887, page 14. (G.S.Q., P. No. 35.)

Two other bores have been put down at Stewart's Creek by the North Queensland Collieries Company, the two bores being 1,000 feet apart. No. 1 North Queensland Collieries Company's bore was sunk in 1903 to a depth of 193 feet by a calyx drill, then continued to 259 feet by a diamond drill. No. 2 North Queensland Collieries Company's bore was sunk in 1904 to a depth of 233 feet by a jumper drill.

At Antil Plains a bore is being sunk in coal measures, but the results, so far, have not been successful.

The following is a list of bores and shafts which have been put down at various times about Stewart's Creek, and their positions are shown on the accompanying plan. (Plate 4.)

STEWART'S CREEK COAL BORES AND SHAFT.

*Twaddles No. 1 Bore—

Position—One chain south of Haswell's Shaft.

Record—89 feet deep in drift. Abandoned.

*Twaddles No. 2 Bore—

Position—At south-west corner of Portion 100.

Record—101 feet in drift. Abandoned.

*Twaddles No. 3 Bore—

Position—At south-east corner of Portion 100.

Record—59 feet in drift, then struck porphyry. Abandoned.

*Twaddles No. 4 Bore—

Position—At the middle of western side of Portion 100.

Record—109 feet in drift, then 39 feet 7 inches in bedded sandstones.

*Simpson and Rodger's Bore—

Position—In Portion 99, 20 chains from northern boundary of Portion 100.

Record—50 feet deep in drift. Abandoned.

*Haswell's Shaft—

Position—Seven chains east of Simpson's Bore.

Record—44 feet deep in drift. Abandoned.

*Townley Coal Company's Bores—

Position—Sunk within a few inches of one another, 30 chains south of Portion 100, on Reserve.

Record of No. 2 Bore—Drift, 26 feet; sandstones and shales, 59 feet; trappean rock, 15 feet; total, 100 feet. Bore abandoned because of an accident.

Record of No. 1 Bore—Drift, 26 feet; sandstones and shales, 58 feet; total, 74 feet.

* Report (M.S., No. 19) by Dr. R. L. Jack, dated Townsville, 29th May, 1888.

Shallow bore—

Position—In Portion 122v, west of Townley bores, between creek and railway.

Record—In drift; depth, 10 feet (?).

North Queensland Collieries Company's No. 1 Bore—

Position—In Portion 150, south of Portion 8v.

Record—Drift, 78 feet; coal measures, 181 feet (coal traces at 86 feet, coal and shale band at 123 feet, 7-inch coal seam at 123 feet); total, 259 feet.

North Queensland Collieries Company's No. 2 Bore—

Position—1,000 feet south of No. 1 bore.

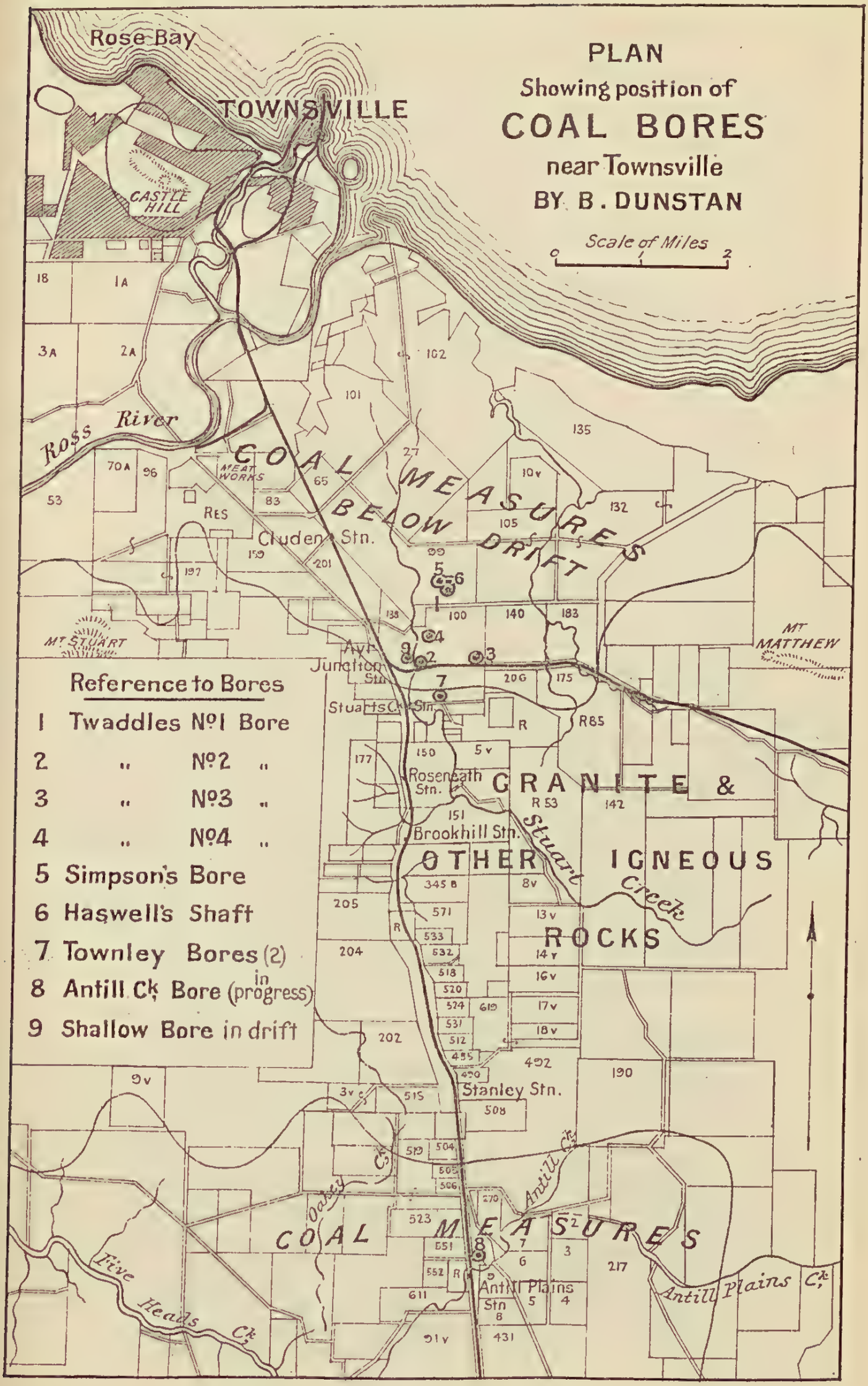
Record—Drift, 33 feet; coal-measure sandstones and shaly sandstones, 200 feet 6 inches; total depth, 233 feet 6 inches.

North Queensland Collieries Company's No. 3 Bore—

Position—Near Antil Plains Railway Station.

Record—Coal-measure sandstones; depth, ?

16th February, 1905.


PLAN
Showing position of
COAL BORES
near Townsville
BY B. DUNSTAN
Scale of Miles
0 1 2
Rose Bay
TOWNSVILLE
CASTLE HILL
Ross River
COAL MEASURES BELOW DRIFT
MEAT WORKS
RES
Cluden Stn.
MT STUART
MT MATTHEW
Ayr Junction Stn
Stuarts Ck Stn
Rosenbeath Stn.
Brookhill Stn.
GRANITE & OTHER IGNEOUS ROCKS
Stuart Creek
Stanley Stn.
Oaky Ck
Antill Ck
COAL MEASURES
Five Heads Ck
Antill Plains Stn
Antill Plains Ck
Reference to Bores
1 Twaddles Nº1 Bore
2 " Nº2 "
3 " Nº3 "
4 " Nº4 "
5 Simpson's Bore
6 Haswell's Shaft
7 Townley Bores (2)
8 Antill Ck Bore in progress
9 Shallow Bore in drift

VII.—THE TESTING OF QUEENSLAND COALS.

The industrial importance of having a series of practical tests made of the numerous varieties of Queensland coals has become so very evident of late that some details of the methods which should be adopted in an investigation might be added to the remark made previously in the Geological Records, No. 1, of 1904.

It may be stated, in the beginning, that we have coals in Queensland which appear to be suitable for every purpose, whether for steam-raising, coke-making, gas-making, smiths' work, or domestic uses.

For steam-raising there are a great number of good coals which can be utilised for general work, some being best adapted for use in locomotive boilers, while others are more suitable for firing marine boilers. Of the latter class, a few have the rare quality of being smokeless, and, therefore, other conditions being favourable, adapted to the requirements of the Admiralty.

Many of the coals are well suited for coke-making, and some of these, with up-to-date plants for washing and coking, would make coke of the finest quality.

In the manufacture of gas for illumination, many of our coals are being used extensively at the present time, and their value in this respect is fairly well known. In the production of gaseous fuel, little is known as to their suitability, and more information on the question is much desired.

The results of numerous tests which have been made from time to time are undoubtedly satisfactory, so far as they go, but no standard tests have been made showing all the qualities of the different classes of coal; and at the present time a consumer of coal has to find out, in the best way he can, which coal suits his particular requirements. For

example, the agent of an English firm desired to introduce a plant for making producer gas for fuel purposes, and wanted particulars as to the merits of the coals on the market. This information could not be supplied, and necessitated the firm making its own inquiries and conducting its own experiments to determine whether the coals which could be obtained answered the purpose.

Such tests should be made officially, and would be for the benefit of that particular firm or any others who desired to introduce some innovation by which the consumption of coal would be encouraged.

If ironworks were established in Queensland, and the respective merits of the coals were required to be known, the desired information could not at present be given except in a general way.

The naval authorities require for their warships a coal possessing certain characteristics. They have made trials of some of our coals, and are anxious to make further experiments, and for that purpose want Queensland coal supplied to them. Such experiments and tests should also be tried here according to some standard, the results of which would help the Admiralty in avoiding the trial of inferior coals, and would be of considerable assistance to those who might desire to open up a coal trade to countries outside Australia.

The oversea traffic in Queensland coal is somewhat limited, and vessels have not taken kindly to the class of coals which here have been offered to them. It is known that some firms condemn Queensland coal generally because of the failure of shipments from one locality, but it should be pointed out to the shipper that there are to be obtained several kinds of Queensland coal, some of which would be bound to answer their purpose, and were the standard tests carried out we would be able to show beyond doubt that no necessity arises for their going outside Queensland for their requirements.

The Railway Department use large quantities of coal on their locomotives and in their workshops, and information as to the quality of the coal on the different fields would indicate those which would best suit them.

The necessity of making standard tests, however, would not arise were the coal supplies of Queensland limited in quantity, but there are ready for development immense reserves of coal in both the Southern and Central districts, and recent discoveries show that the Northern district will possibly be a producer of coal, even of anthracite, in the future.

The methods to adopt in testing would take into consideration all the qualities of a coal, so as to determine their fitness for stationary, marine, and locomotive boilers, for coke-making and for smelting furnaces, for use in smiths' forges and for domestic purposes, and for the making of gas for fuel and for illumination.

The examination should include the following tests:—

Ultimate chemical analysis.
Approximate chemical analysis.
Estimation of calorific values by formulæ.
Tests in a standard calorimeter.
Calorimeter tests in a standard boiler.
Trials in a locomotive engine.
Trials in a marine engine.
Trials showing behaviour in transit.
Trials showing liability, or otherwise, to spontaneous combustion.
Trials in a coking-oven.
Trials in a gas retort.
Trials in a gas producer.

The trials and tests should be under the control of a number of professional men, each to be a specialist thoroughly acquainted with some branch of the work, and whose experience, personal supervision, and interest in the work would guarantee the tests being carried out faithfully and systematically.

The constitution of such a body of professional men must necessarily be composed of an analytical chemist to undertake the chemical analyses and the laboratory calorimeter work, and marine and locomotive engineers to supervise the boiler tests. The coking and the gas experiments would be conducted by men expert in those branches, while a geologist would be held responsible for the production of the bulk samples from the mines, would define the position and character of the seams of coal from which the samples would be obtained, and also furnish other geological data concerning the probable supply of coal on the fields.

The above would form a coal-testing board on the lines of many such other boards which have accomplished similar work in other countries, all the members of which, with one or two exceptions, could be selected from officers in the Government service.

6th February, 1905.

VIII.—MINERAL NOTES.

AGATE AT LITTLE RIVER.

Little River is a small stream which is crossed on the coach route between Georgetown and Croydon, and the position of the agate deposits examined by the writer is about 30 miles easterly from Croydon.

The surface rocks are principally Desert Sandstone (?) and a partly decomposed basalt, the latter evidently being older than the former, as the agates which have formed in the basalt occur as pebbles in the sandstone.

The basalt is traversed by quartz veins evidently formed at the same time as the vesicles in the basalt, which are filled with agate, and the abundance of agate pebbles on the surface of the decomposed basalt indicates that a large area of this rock has been subjected to the infiltration of silica. The Desert Sandstone (?) is in part changed to "billy" (the surface quartzite found so commonly in Queensland), and nearly all the hills around are capped with it. Below the beds of sandstones and the flows of basalt the rocks are felsites.

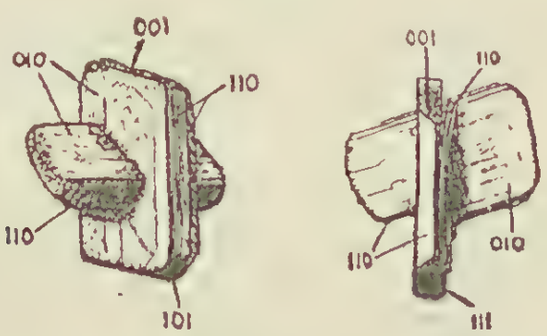
The agates are not of large size, four inches being about the maximum in diameter. The banding and colouring are beautiful in some of the specimens selected for examination, but in the larger sizes the centre is usually crystalline quartz, with calcite also occasionally present. Some specimens, sectioned and polished, are shown in the Geological Survey Museum, Brisbane, and may be taken as types of Little River agates.

At the Percy River, about 60 miles south of Georgetown, more extensive deposits of agates are known; here the nodules of agates are said to be much larger, and in even greater abundance.

GYPSUM TWIN CRYSTALS AT EUKALUNDA, NEAR BOWEN.

Specimens of gypsum penetration-twin crystals have been received by the Geological Survey Office, Brisbane, from Eukalunda, near the Durham Mine, where they are stated to occur in a formation in granite close to sedimentary rocks.

Fig. 3.



GYPSUM PENETRATION-TWIN CRYSTALS.

The accompanying figure illustrates two of the twin crystals, the drawings being made to natural size.

TELLURIDES OF GOLD, SILVER, AND LEAD AT GYMPIE.

Two tellurides, Hessite and Altaite, occur in a number of places below the 600-feet level at the No. 2 South Great Eastern Mine, Gympie. The specimens here described were received some time ago, but have only recently been examined.

The Hessite is of a lead-gray colour; has a bright metallic lustre; fracture, varying from irregular to sub-conchoidal; hardness, about 2; and sectile. The percentage of silver in the mineral is 50.339, that of the gold being 5.049. Tellurium percentage undetermined; sulphur, absent; specific gravity, 8.50.

The Altaite is remarkable for its very distinct cubical cleavage; the colour is tin-white on a fresh facture, which rapidly tarnishes to a greenish-yellow bronze, this on exposure changing to pale yellow-bronze; hardness, 2½; sectile. The blowpipe and other reactions indicate the presence of the tellurium and lead, with traces of sulphur. The percentage of gold present is 0.09, that of silver being 0.70; specific gravity, 8.10.

The two minerals are in a matrix of quartz and calcite, and together constitute about 50 per cent. of the mass. Native gold and minute traces of a brownish mineral (probably siderite) are also present.

CALCITE CRYSTALS WITH PYRITES INCLUSION, AT GOLDEN GATE, CROYDON.

(PLATE 5.)

In the block shaft being sunk at Roger's Extended Mine, on the Golden Gate line of reef at Croydon, a quartz reef has changed into calcite, in the cavities of which calcite crystals have been formed.

Figure 2, Plate 5, shows the general appearance of the crystals as they appear in groups, with the lines of pyrites inclusions passing through them. Figure 1, on the same plate, illustrates the character of the twinning, the pyrites dust inclusions on the terminal faces, and the median line of microscopic crystals of pyrites traversing the group of calcite crystals at right angles with the principal axis.

Brisbane, 8th April, 1905.

NATIONAL MUSEUM VICTORIA

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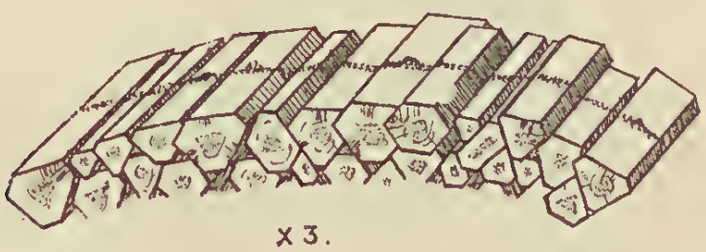
CALCITE

ROGER Nº 1 MINE GOLDEN GATE CROYDON

Showing the inclusions of particles of Pyrites
in a twinned group of Calcite crystals

Fig. 1



x 3.

Fig. 2

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GEOLOGICAL SURVEY OF QUEENSLAND.
Publication No. 197.

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